THE IMPORTANCE OF RADIOSCOPY IN THE DIAGNOSIS OF OESOPHAGEAL AND GASTRIC DISEASES

- by -

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I

INTRODUCTION.

No department of Medicine has made such rapid strides within the last Fifty years than that which deals with Diseases of the Alimentary Canal. Brinton, in 1858, wrote concerning Pathological processes in the Stomach "Exact Physical information is almost denied us." Brinton's researches produced a series of "Lectures on the Diseases of the Stomach." There was apparently no advance in the subject until Fifteen years later when, after Kussmaul had introduced lavage into gastric therepeutics, Von Leube extended the use of the stomach tube to diagnosis as well as treatment. The knowledge of the chemical functions of the Alimentary Canal were revolutionised by the adoption of test meals in diagnosis, and the introduction of X Ray methods in gastric diagnosis has been a still more remarkable advance.

Before one can attempt to study the nature of Gastric diseases, an understanding of the normal anatomy and physiology of the organ is essential. In regard to the oesophagus this was comparatively easy so far as the anatomy of the organ was concerned. But with the stomach it was a far more difficult problem for the reason that prior to the adoption of the X Rays as a method of investigation, one had to depend on the appearances presented on the operating table or at a post-mortem examination, and here two important

factors which influenced the living working organ were absent, namely tonic action and peristalsis. Wepper in 1679 observed peristalsis in the stomachs of living wolves, dogs and cats. Schwartz and Haller performed similar experiments in the Eighteenth century. But no further advance was made until 1833 when Beaumont published his researches on the gastric fistula of Alexis St Martin - (the fistula was the result of an accidental gun-shot wound-) Pawlow and his Pupils made a number of important observations on the motor activity of the stomach and pylorus in the course of their investigations on the work of the digestive glands. Pawlow made use of oesophageal, gastric, and doudenal fistulae. All these observations were, therefore, made under abnormal conditions.

In 1897 Cannon published his observations on the gastric movements studied in the cat by means of the X Rays; and Roux and Balthazar studied the same subject on animals by the X Rays independently of Cannon's work. This was the first effort at a study of the normal action of the stomach under really physiological conditions. Roux and Balthazar shortly after applied this method of investigation to man, but no very definite results were obtained until 1904 when Reider showed that large doses of bismuth could be

taken without ill results. Since Reider introduced the subject there have been many workers in the field and such men as Holzknecht, C.Kaestle and J.Rosenthal, Franz M Groedel, Hertz, Leven, Barrett, Barclay, Jordon, Morton, and in America Pfahler, Hulst, Cole occur to one.

The anatomy and physoilogy of the oesophagus and the stomach have been carefully observed and a method of diagnosis has been introduced which is of primary importance.

It may be said that in oesophageal disease Radiography has not the important claim that it has in gastric disease. This may be so, but there is no doubt that investigation by means of a bismuth pellet or emulsion in a caseof suspected oesophageal stricture is a far safer and pleasanter operation than the former method of the stomach tube and bougie. The oesophagoscope enables one to make a direct examination of the oesophagus, but it is not without risk and there is no comparison between the comfort of Roentgenoscopy and the discomfort of the oesophagoscope, tube or bougie. Although Radiography has assumed such an important position in the diagnosis of gastric diseases, the history and other clinical methods are of the utmost importance. In a case of Pyloric Stenosis a test meal will often yield invaluable knowledge as to the

etiology of the condition. On the other hand, the clinical methods of ascertaining the dimension and position of the stomach by percussion, auscultatory percussion, etc, have shown to be most uncertain and often fallacious.

The X Rays as a method of diagnosis would appear to be a simple detail. This, unfortunately, is not the case, as the interpretation of the shadows one sees on the fluorescent screen and photographic plate require considerable skill and experience. It is important to remember that we are studying the shadow of the contents of the stomach and not the stomach itself. If the meal one administers does not completely fill the stomach, the picture obtained is only a partial one, and this might easily mislead an inexperienced observer. In a case of Gastric Atony the bismuth falls to the most dependent part of the stomach, and thus the shadow only informs one of the condition of the lowest part of the stomach, and no shadow is obtained of the rest of the organ. In such a case, one must study the manner in which the food passes from the upper portion of the stomach to the most dependent part and a considerable amount of useful information can thus be obtained as to the condition of the parts of the stomach above the most dependent part.

A point of importance is the fact that the stomach juices are lighter than the bismuth meal and consequently right above it. Hence the stomach which may appear to be atonic, as the shadow is only cast by the bismuth food at the most dependent part, may in reality be tubular and normal, the juices secreted, which lie above the meal, not casting any shadow. Such a condition may arise in Reichmann's disease.

The lowest border of the stomach is well below the umbilicus in atony; this however is no proof of atony, as the whole stomach may be displaced downward and give this same shadow, as in Gastroptosis.

Mistakes in diagnosis may therefore be made quite easily, and it is only possible to arrive at any valuable conclusion by continued examination with the fluorescent screen.

In this Thesis I propose to outline the method of applying the X Rays in the diagnosis of Oesophageal and Gastric Ailments. I shall endeavour to demonstrate the true Anatomy and Physiology of the Oesophagus and Stomach, and then show how this knowledge can be utilized in determining the nature of lesions which disturb the normal state of these organs both Anatomically and Physiologically.

II

TECHNIQUE OF OESOPHAGEAL EXAMINATION.

The Oesophagus is situated in the posterior mediastinum close against the spine, with the heart and aorta in front of it; a good view cannot therefore be obtained antero-posteriorly to the line of the rays, but one can get an excellent view in the oblique position. The patient ought to be examined standing to enable the food to descend. The most recent method of examining is to seat the subject on a revolving saddle the seat of which can be raised or lowered. His body is supported by a canvas back which revolves with the seat, and can be clamped in any position, front, back, or oblique. The most favourable oblique angle must be determined by fluorescent screen examination in every case. The X Ray tube is placed in a protective box or shield, which is capable of being easily moved to any position in a vertical plane. It is important to have an adjustable rectangular diaphragm fitted to the box, for most of the observations on the oesophagus require the diaphragm reduced to a narrow vertical slit.

The fluorescent screen is glazed with lead glass of tested opacity. The opaque lead glass serves two purposes - it is X Ray proof, and so protects the Operator and his Assistants; and on it can be painted what is seen. It as a still further precaution, in addition to the enclosed tube box and the lead glass

screen, the Operator uses X Ray gloves, there is no danger of dermatitis or anything else.

The method I have adopted when examining the oesophagus differs somewhat from the above. The X Ray tube is placed in an adjustable box which can be raised or lowered at will, and fixed in position by a screw and lever. In front of the tube I place a table, and get the patient to stand with his back against it, his heels just touching the table. I adjust the tube to the required level, and then an Assistant turns out the light and switches on the current. With the fluorescent screen to guide me, I turn the patient into an oblique position so that the front of the right shoulder is against the screen, and until I can discriminate between the shadows thrown by the Aorta and that of the Spine. With the Screen held in position, I tell the patient to swallow the gelatine cachet or bismuth emulsion and watch its progress down the oesophagus.

The chief forms of bismuth preparation used to show the condition of the oesophagus, include, gelatine capsules containing dry carbonate, emulsions, and bread and milk or similar meals. I have used the capsules, and a meal composed of arrowroot gruel and bismuth subcarbonate. Barium carbonate has been recently used with good results.

I usually begin with the mixture; this is placed in a glass or mug, which the patient holds with his left hand; the room is darkened, and the current started, and the patient is directed to drink some of the emulsion. The rate at which it descends depends principally upon the emulsion; it is shot rapidly, by the act of swallowing, through the pharynx, and then passes through the oesophagus mainly by its own weight. It is difficult to make out genuine peristalsis in the oesophagus. I need hardly say, of course, that peristalsis does occur, for this can be proved beyond question. Dr Hertz in 1907 (4) made X Ray observations on normal individuals, watching them swallow bismuth while in the recumbent and in the inverted posture, as well as when erect. He says that while lying down the food moved as rapidly as when erect, and even when the Individual was inverted it moved steadily upwards until it reached the Cardia, though only at about one-third the rate it descended in the ordinary erect position. As peristalsis must be the cause of the movement in the inverted position, he assumed, that it would be the chief factor in the erect position. Undoubtedly peristalsis does occur in the oesophagus, but it is difficult to make out, and even when there is stenosis of the oesophagus, one seldom sees the powerful

peristaltic waves which one would expect after having seen marked peristalsis in the stomach as a result of pyloric obstruction.

There is commonly some slight delay and deviation from a stright course, at the level of the bifurcation of the trachea. The narrowest part of the oesophagus is undoubtedly its lowest limit - the cardiac orifice - and here the emulsion always tends to collect for a few seconds before entering the stomach. It is important to remember that a bismuth capsule may be held up in the oesophagus when there is no obstruction. It frequently happens that a bismuth capsule is held up at the cardiac orifice for as long as fifteen or twenty minutes in a normal oesophagus, and the patient may drink large quantities of water without dislodging it.

III

ANATOMY AND PHYSIOLOGY OF THE OESOPHAGUS.

and

DISEASES OF THE OESOPHAGUS.

THE ANATOMY OF THE OESOPHAGUS.

The Anatomy is quite definite, and was not in doubt before the advent of Radiography. The reason of this, of course, is that the oesophagus is a fixed body, and examination of it post-mortem is as good as examination ante-mortem.

PHYSIOLOGY OF THE OESOPHAGUS.

X Rays have been most useful in studying the movements of the oesophagus, and the work of Cannon on animals stands out preeminently.

Magendie in 1836, divided the act of deglutition into three parts corresponding to the anatomical region of the mouth, pharynx, and the oesophagus. The muscles of each of these divisions were considered the active agents in propelling the food onward.

Mosso in 1876, was the first to make direct observations on the movements of swallowed masses in the oesophagus. The oesophagus of a dog was laid bare, and a transverse incision made through it, or a piece of it excised. A small wooden ball was placed in the canal below the excised part, and the animal was then stimulated to swallow. One or two seconds after the contraction of the pharyngeal muscles a peristaltic wave began to

traverse the oesophagus. This wave did not stop at the point of excision but in due time reappeared below and carried the ball to the stomach. Thus the act was shown to be controlled by the Central Nervous System. Peristalsis was so plainly the motive power, that the action was never doubted. Yet this belief was soon to be questioned.

In 1880 Falk and Kronecker studied the movements in the mouth and pharynx, and advanced the theory that deglutition was the result of the rapid contraction of the muscles of the mouth. As arguments for rapid descent, they stated that cold water can be felt in the epigastric region almost immediately after being swallowed. Further, when strong acids pass through the oesophagus, they corrode only small parts of it, and not the entire mucous membrane, as would be the case if the acid were carried to the stomach by peristalsis.

In the same year Kronecker and Meltzer carried out further experiments connecting rubber balloons, placed in the pharynx and the osephagus respectively, with Marey's tambour. When water was swallowed, the increase of pressure in the pharynx produced a curve, and almost immediately afterwards the oesophageal balloon was compressed and produced its curve below the first. After a varying number of seconds, the

oesophageal balloon recorded another curve, caused by a peristaltic wave which carried to the stomach any fragments left in the canal. From these experiments Kronecker and Meltzer concluded that liquids, and semi-solids, are carried to the stomach not by peristalsis, but are squirted down the oesophagus by the rapid constraction of the muscles of the mouth. Further, the succeeding peristalsis is of use merely in gathering up adhering fragments, and carrying them to the stomach.

Later, these experimenters somewhat modified their views, and they then maintained that the mass was not squirted into the stomach directly, but stopped a short distance above the cardia, and here it remained until carried into the stomach by the succeeding peristalsis. The care with which these experiments were conducted received general assent, but this work was done with liquids and semi-solids only, and solids were not investigated at all.

In 1897 Cannon (2) did a series of investigations on the movements of the oesophagus studied by means of the Rontgen rays. He used bismuth sub-nitrate.

For the first experiments he selected the goose. When a bolus of corn meal mush mixed with bismuth was placed in the pharynx, it descended slowly, and regularly, and occupied about 12 seconds in passing

over a distance of 15 centimetres. An average of over 100 such observations showed that the rate became slightly slower as the bolus proceeded.

In order to test liquids, molasses was mixed with bismuth to such a consistency as to drop easily from a glass rod. When this was fed with a pipette it flowed slowly and regularly down the oesophagus - clearly by peristalsis. The rate was about the same as for solid food.

In Cannon's experiments on the cat, the animal was placed on its back and left side on a holder; the extremities were secured by straps; the head was held between two upright rods connected above by a thong - this allowed free movement of the head without resistance. Shreads of meat dipped in bismuth were ordinarily masticated, and swallowed without difficulty. For soft solids, bread and milk were used so fluid as to be easily drawn up into a pipette. The insolubility of the bismuth salt rendered the study of the liquids more difficult. A simple mixture of milk and bismuth, shaken in atest tube, and immediately drawn up into a pipette, was found most practicable.

When studying solids, it was found the descent the entire way was by peristalsis, but the rapidity varied. The duration of the movement in the cervical portion was $2\frac{1}{2}$ seconds, and in the thoracic region a little less.

At the lower end of the heart there was sometimes a decided pause. In the section from the heart to the stomach, the movement was decidedly different. The rate was always very slow, although the distance was less than one-third of the entire canal. The character of the movement here was also peculiar, the bolus descending with each inspiratory movement of the diaphragm, and remained stationary, or descended very little, with expiration. Thus a series of hitches seemed to carry the bolus to the cardia. The probable explanation of this peculiar movement is that the stomach, and lower oesophagus, were pulled down with each descent of the diaphragm. This would make the movement appear irregular although it was really a slow peristalsis.

Semi-solids, a mush of bread and milk, descended in the same way as solids; but the rate was slightly faster in the upper oesophagus, for the bolus took a second less to reach the cardiac level. From here the rate was much the same as the solids.

For liquids, 1½ to 2 seconds sufficed for the descent to the mid-heart region. Here there occurred a long pause, then the oesophagus apparently contracted above the liquid which slowly passed on to the stomach.

Thus, in the cat, the lowest section presents no change ascribable to consistency, while in the upper sections

the rate does slightly increase with the more liquid character of the food.

In dogs, the general phenomena were the same, except that there was no slackening of speed in the diaphragmatic regions, as was observed in the cat. Thus in the dog, and cat, but little variation was seen in the swallowing of liquids and solids.

In horses, for instance, there is a decided variation in the rate of movement in the oesophagus. Liquids shoot along the gullet, while solids move clearly by peristalsis.

Cannon remarks that X ray method lends itself less successfully to the study of deglutition in man, than in other animals. The thickness of the thorax, the distance of the oesophagus from the surface, and the relation to dense tissues, render the observation of a swallowed mass difficult. He used Gelatine capsules containing bismuth, for the study of solids, and these were traced to a point below the heart. The motion was very regular and apparently due to peristalsis, for the bolus descended without a hitch or irregularity of any kind. Sometimes the capsule became fixed in the upper oesophagus at about the level of the second rib. Repeated swallows of water would fail to dislodge it. With each attempt at swallowing, the capsule would rise slightly as if the oesophagus

was pulled up with the rise of the larynx; then the capsule would descend to its former position. Semi-solids - bread and milk - could be seen about as far as solids - i.e. to just below the heart. The motion of the bolus was the same as with solids, except that the rapidity was perhaps slightly greater. Liquids - bismuth and water - were seen only in the neck, and upper thorax. Here there was a decided squirt. With the rise of the larynx, the liquid was seen to pass rapidly through the pharynx, and well down into the thoracic oesophagus, before it was lost to observation.

Thus in man, according to Cannon, the rapidity of descent depends upon the consistence of the substance, liquids travelling faster than semi-solids and semi-solids faster than solids. Dr Jordon (3.) appears to agree with this, for while discussing the question of the oesophageal movements and the rate of descent, he says "the rate at which it descends depends principally upon the thickness of the emulsion; it is shot rapidly, by the act of swallowing, through the pharynx, and then passes through the oesophagus by its own weight. I have seen very little evidence of genuine peristalsis in the oesophagus, the main propulsive force being gravity, both in health and disease" Later on Dr Jordon says that he does not deny the

existence of peristalsis in the oesophagus, but thinks it plays a small part in examination of the oesophagus. I have already alluded to Dr Hertz's views on the question of peristalsis. He is convinced that the movement of the food is mainly due to peristalsis, and independent of gravity.

Dr Harrison Orton (4) says he has seen a condition of reversed peristalsis in the oesophagus. He has seen a cachet carried down to the seat of an obstruction, then rise in small jerks 4 or 5 inches, and then drop again on to the stricture, and again rise but not quite so high. He had noticed this several times before it finally settled down on to the stricture. Dr Jordon however, says that this occurs in the upper part of the oesophagus at or above the level of the aortic arch, and he believes it to be due to pharyngeal muscular contraction, which restricted the space so much that the capsule or emulsion was forced up.

One might summarise the phenomena of oesophageal deglutition as follows.-

1. There is a difference in swallowing according to the animal and the food which is used.

2. In fowls the rate is slow, and the movement always peristaltic without regard to consistency.

3. In the cat the movement is always peristaltic, and slightly faster than in fowls.

4. In dogs the phenomena are much the same as in cats.

5. In man, by the mechanism of deglutition, the food is shot rapidly by the pharynx into the oesophagus. The rate of descent then depends upon the consistence of the substance swallowed. The mechanism is the result of peristalsis, which is difficult to demonstrate, and the descent, normally, is probably aided by gravity.

RADIOLOGY OF NORMAL OESOPHAGUS.

The healthy oesophagus as a rule throws no shadow, although occasionally, above the level of the highest point of the aortic arch, a thin clear vertical shadow may indicate its position.

By the act of swallowing the bismuth emulsion passes with great rapidity to the back of the pharynx, and then passes rapidily down the oesophagus. There is some very slight delay at the level of the bifurcation of the trachea, and then quite an appreciable delay at the cardiac orifice owing to the diminution of the lumen of the oesophagus at this point. From this point it runs slowly into the stomach and the upper limit of the meal becomes horizontal.

I have already mentioned that peristalsis of the oesophagus does occur, and most observers say they can demonstrate it. I have never seen peristalsis such as one sees in the stomach, but Hertz ( ) says that in cases of obstruction strong peristaltic waves can be seen trying to overcome the obstruction.

OESOPHAGEAL OBSTRUCTION.

This may be. -

1. Spasmodic due to (a) Neurosis
   (b) Inflammation
   (c) Foreign body
2. Cicatricial following burns by boiling fluid, strong acids or alkalies swallowed by accident, or in attempted suicide; ulceration duty to syphilis, or tubercle.
3. Foreign bodies - plum stones etc.
4. Oesophageal piles.
5. New growths in the wall of the oesophagus
   (a) At the upper end (it is here that oesophageal pouches occur most frequently)
   (b) The middle portion
   (c) The lower end.
6. Tumours, causing pressure on the oesophagus, but situated outside the oesophagus.
   (a) Masses of glands (tubercular, cancerous gummatous, lymphadenomatous.)
   (b) Primary growths in lungs or mediastinum.
   (c) Pleural, or pericardial effusion.

7. Aneurism. (a) Ascending arch.
(b) Transverse arch.
(c) Descending aorta.

8. Enlarged thyroid.

1. Spasmodic obstruction.

(a) Neurosis. On examination with the Rontgen Rays, one finds that the bismuth is held up at some point in the oesophagus, but only momentarily, and the emulsion then passes on normally. If a capsule is used it may be held longer as the spasm grips it firmly. Occasionally the obstruction is said to persist, and lead to dilatation of the oesophagus.
Cardiospasm is a neurosis causing such spasmodic obstruction. The tendency at present is to assign this disease to a condition of primary oesophageal atony, as a result of degenerative changes occurring either in the vagus nerve, or autonomous nervous system. Oesophageal atony is indicated when the food passes down the oesophagus in segregated masses, each mass corresponding to a separate bolus of food.
Dr Harrison Orton (6) says "A narrowing of the shadow with bismuth is very important. If that thin stream followed after a normal shadow it was very much against spasm as a rule. And if it was due to spasm, by

giving more bismuth the spasm would give way, and a needle would pass through" Spasm does not necessarily occur exclusively in patients who are neurotic. Hertz (7) thinks cases of spasm may occur in persons with no other trace of neurosis, and the spasm may be so severe as to lead to enormous dilatation of the oesophagus. Some cases of spasm were cured by the passage of a bougie on a single occasion. But, the fact of being able to pass a bougie in cases of oesophageal obstruction, does not indicate spasm definitely; for where there is definite organic obstruction one frequently finds, that although a bismuth meal is held up, a bougie can still be passed.

The following case illustrates spasmodic obstruction:- S.M.- male - aet.19. This patient had difficulty in swallowing solids and at intervals he could not even swallow semi-fluids. X ray examination showed, that at the cardiac orifice there was some slight obstruction to the bismuth meal, and more time was required for it to pass than in normal individuals.

The patient was examined under chloroform, and bougies passed without difficulty. He was oesophagoscoped and no signs of pathological stricture were seen, the oesophagoscope passing into the stomach with ease. A diagnosis of spasm was made and the patient was treated for neurosis.

(b) Inflammation. Immediately after swallowing a strong acid one gets spasmodic stricture of the oesophagus, and this later goes on to organic and permanent stricture. In such cases the administration of bismuth emulsion may act as a sedative, and relieve the spasm but, of course, merely temporarily.

(c) Foreign body. A foreign body is gripped by spasm which may persist, and cause obstruction until the body is dislodged. The irritation of a foreign body may cause a spasm in a higher situation.

2. Cicatricial stricture.

This follows the swallowing of strong acid or alkalies, or tuberculous or syphilitic ulcers. At first the stricture is a spasmodic one, but later fibrous. The bismuth meal at first is only delayed in its transit, but as the stricture contracts it is held up more definitely, and finally the emulsion may not pass at all. Such a case as this was admitted in September 1911 J. B. male - aet 4. - Sec Case 1. He had unfortunately swallowed a considerable amount of hydrochloric acid. At first, there was spasmodic stricture, and he could swallow the emulsion with difficulty; later on, however the stricture became so

tight that the emulsion was completely held up, and bougies could not be passed.
He was operated on in November and attempts were made to dilate the stricture from below but this was found to be impossible. He had a gastrostomy performed but eventually succumbed

See Case No 1. Plate No 1.

3. Foreign Bodies.

These are usually swallowed by children, and consist of metallic coins, or toys, which can be easily seen on the fluorescent screen. My last case of this sort was a boy who had swallowed a nail. This was held up for some time low down in the oesophagus - apparently as a result of spasm, but eventually I saw it in the stomach. He passed the nail two days later. Dr Jordon (&) describes an interesting case of a Lady, age 48, who had been perfectly well until three months before consulting him, when she began to vomit after food. The vomiting became more frequent, and more copious, until she vomited all her food, and began to lose weight rapidly. She was diagnosed to have pyloric obstruction, almost certainly due to a Cararcinoma of the pylorus. She was given a glass of bismuth emulsion to drink, and the Operator was

surprised to see it began to collect at the bottom of the oesophagus and continued to mount higher and higher up the greatly dilated oesophagus, while only a very thin stream ran through the cardiac orifice and entered the stomach, which was normal. Most of the emulsion was vomited a few minutes later. A bougie was then passed, and obstruction was felt at the cardiac orifice; but on applying a little pressure the obstruction yielded, and the bougie entered the stomach with ease. Thereupon the patient made a complete recovery, a thickish emulsion passing through readily two days later though there was still some indication of dilatation of the oesophagus for a day or two.
The cause of obstruction here might have been spasm ; but Dr Jordon thinks it was not, as the patient was a very sensible woman, and showed no signs of neurosis; he ascribes it as due to the impaction of some foreign body, a plum stone or a tough piece of sinew, which was displaced by the bougie. The patient had no recurrence.
Dr Thurston Holland (q.) describes a case where a woman was said to have swallowed a portion of a vulcanite tooth plate two months before, and the symptons she presented were lung symptons, and were thought to be due to phthisis. On the screen in the semilateral position, at about the level of the sixth dorsal

vertebra, could be plainly seen a foreign body. Bismuth emulsion was seen to go right down the oesophagus, and to impinge on, and be partially obstructed by the foreign body. Although the plate was successfully removed, the patient died of septic bronchitis, and at the post-mortem examination it was found that the plate had ulcerated right through the oesophagus and into the left bronchus.

In addition to such cases as these, it follows that foreign bodies impacted in the oesophagus which are translucent to the X rays, can be made opaque by bismuth mucilage which would stick on to them when it was swallowed.

4. Oesophageal piles.

Dr Jordon describes this as a form of obstruction occurring at the lower end of the oesophagus. He says, that this form of obstruction will allow a bougie to pass through without any resistance, whereas an emulsion, and still more a capsule or a solid meal will be held up, and only passed through in a thin stream and at a slow rate. Dr Hertz doubts whether such a condition could give rise to obstruction and he argues, I think reasonably, that a bolus of food would obliterate such an obstruction. Dr Jordon suggests that a capsule, or bolus of food might rest

on a bunch of dilated veins, and then one would naturally get an obstruction simulated. In cases of Cirrhosis of the Liver one does, of course, have attacks of vomiting, but this is usually ascribed to the stomach condition, and not to an oesophageal obstruction, though severe haematemesis may occur from rupture of the veins at the lower end of the oesophagus.

5. New growths in the wall of the Oesophagus.

a. At the upper end. Cancer of the upper end is not as common as that in the middle, and lower end. The appearance of cancer in the upper end is characteristic, and it leads to the formation of a pouch which is well demonstrated by the bismuth. From the bottom of the pouch a thin stream of bismuth emulsion may be seen trickling through the stricture and running down the entire length of the tube. Sometimes the actual growth may be seen at the lower end of the pouch.

b. At the middle. New growths here are usually at the level of the bifurcation of the trachea. The bismuth is held up above the stricture, and the thin thread is seen passing from the stricture downwards. Growths here tend to grow along the tube, and consequently the outline of the bismuth shadow is an irregular one. Growths here tend to perforate, the bismuth emulsion entering the posterior mediastinum

or one of the bronchi, the bronchus in such a case being perforated secondarily from the posterior mediastinum. Jordon(8) quotes and illustrates a most interesting case - When the patient drank the emulsion it passed down to the affected part; here a thin stream ran through the stricture; another stream, thin and irregular entered the bronchus and finally the root of the lung where it collected in a small pool or began to radiate along the small bronchioles. The patient then began to cough and brought up phlegm mixed with bismuth

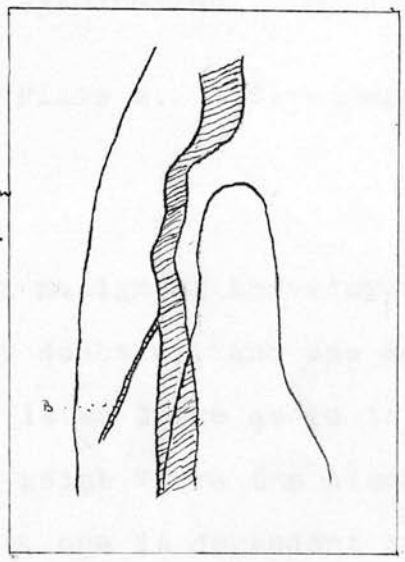


Diagram in the right anterior oblique view showing Carcinoma of the oesophagus, with bismuth emulsion in the oesophagus. The middle portion of the oesophagus is irregular, and there is a perforation downwards and to the right from which the bismuth emulsion entered the right bronchus.(8)

See Case No 2. G. C. - male - aet 47.

c. <u>At the lower end</u>. New growths in this situation are usually squamous epethelioma; but Columnar Carcinoma can occur, and Schaffer has demonstrated the existence of columnar epithelium in the last inch of the oesophagus. Glandular enlargement is

more common when the growth is an epithelioma originating in the oesophagus itself. The bismuth emulsion is held up here right at the lower end, and consequently one gets the whole oesophagus dilated, and showing as a long dark shadow. In some of these cases the growth is an extension from the stomach to the oesophagus and in such a case it may be possible to pass a bougie into the stomach, the soft growth being pushed aside - thus one might miss the fact that the growth was extending, but for the evidence afforded by a screen examination

See Case No 2 - Plate 2. G.S. - male - aet 56.

The diagnosis between malignant and simple stricture is in most cases very doubtful, and one can only be sure when the growth is so large as to throw a shadow on the screen below the point where the bismuth is held up. For a diagnosis, one is dependent on the history- previous and family - the rate of growth, age of the patient, evidence of glandular enlargement. One hopes that some method will be arrived at whereby the growth will be shown more frequently. The Oesophagoscope is certainly a distinct advance.

6. Tumours etc causing pressure.

Tumours of the mediastinum, lungs, pleura, or glands at the root of the neck may cause obstruction by pressing on the oesophagus. The appearances in these cases vary and one cannot give a fixed description. I have had two very typical cases of presaure from enlarged tuberculous glands

(1) S. M. - male - aet 2 - In this case the diagnosis was very doubtful it being thought possible that the case was one of Congenital Pyloric Obstruction. However, there were enlarged tubercular glands in the neck, and on examination with the X rays and bismuth meal one found a distinct obstruction above the position of the bifurcation of the trachea. The child could just swallow milk and fluid foods and after a stay of three months in the Hospital was discharged practically"in statuo quo"

(2) G.R. - male - aet 43 - This man came to the Out-Patient Department complaining of difficulty in swallowing and hoarseness of voice and cough. It was thought to be a case of Aneurism of the Aorta, but X ray examination showed no increase of shadow in the Aorta. He was admitted to my Ward. He had some sign of early tubercle in both apices. His condition progressed, and he developed paralysis of his left vocal cord, still more difficulty in swallowing, and

lost weight. Enlarged glands were thought of, and he was given a bismuth meal, and at the bifurcation of the trachea there was a marked delay in the downward course of the emulsion. One thought the enlargement of glands might be specific, tuberculous, or malignant. He was given increasing doses of Pot. Iod. but with no improvement. He eventually died, and at the autopsy at the root of the neck a mass of caseous glands was found. There were also enlarged bronchial glands, and tuberculous broncho - pneumonia in the lungs. I venture to suggest, that but for the help of the X rays in excluding Aneurism and suggesting pressure from some other cause no diagnosis but that of aneurism would have been made in this case previous to the post-mortem examination.

7. Aneurism.

In a case of oesophageal obstruction aneurism as a cause must always be excluded before passing bougies or an oesophagoscope. But it is rare for aneurism to be so obstructing the oesophagus as to cause serious difficulty in swallowing. A large Aneurism of the Arch may be present and there may be no obstruction to a bismuth meal.

Two kinds of aneurism of the Descending Aorta may be described:-

(1) A general atheromatous dilation, in these cases a bismuth emulsion spreads itself out into a wide band of rivulets which descend in slow tortuous courses between the dilated aorta and the spine. The oesophagus is evidently flattened out between the two unyielding structures - the atheromatous dilated aorta and the spine. An Aorta of this kind when removed after death and examined by the X ray, shows numerous atheromatous patches.

(2) The second form is that of a saccular aneurism of the descending thoracic aorta. The saccule is seen in the oblique view as a rounded shadow in the posterior mediastinal clear space, displacing the heart forward and the aortic arch with it.

See case W. P. - male - aet 47. No 26

Oesophageal pouch.

This well recognized condition is very often a difficult one to diagnose, and in its features closely resembles oesophageal obstruction, to which as a matter of fact, it may give rise. The history of small fragments of unchanged food being regurgitated some hours after having been swallowed is always suspicious of this condition. An X ray examination with bismuth emulsion will often help, and the appearance one gets is that a small part of the bismuth swallowed remains in the oesophagus long

after the rest of the meal has passed on to the stomach. An X ray photograph alone would give a picture very like that obtained in a case of true oesophageal obstruction, so that one ought to examine such cases, and in fact all cases, most carefully with the screen before taking a Radiograph. Also by giving the patient a bismuth meal and subsequently passing a bougie along the oesophagus, a photograph may be taken which definitely shows the position of the pouch in relation to the oesophagus.

Oesophageal Atony.

Diagnosis from Oesophageal Obstruction.

In Oesophageal Obstruction, food passes down normally to the obstruction, and then is held up for an inderinite period, or returned by antiperistalsis. In primary Oesophageal Atony the food passes along the Oesophagus in separate boluses as it is swallowed, and the steady finger like projection of the normal is not seen. The food may be held up at the Cardia, but when sufficient is taken, may pass on into the stomach; peristaltic waves are absent, and oesophageal dilatation is seen to be intense.

IV.

TECHNIQUE OF GASTRIC EXAMINATION.

When examining cases of gastric disease I have been in the habit of using the method of the Double Bismuth Meal.

The patient was given his first bismuth meal at 9 a.m. on the day of examination. He had his last big meal some twelve hours previously so that at the time of administration of the first bismuth meal his stomach ought to have been empty. The meal I gave as a rule was the following -

Bismuth Sub-carbonate --- ounces 2

Arrowroot gruel ---------- pint 1

I have sometimes substituted bread and milk for the arrowroot gruel. It is perhaps surprising that I still use the Carbonate in spite of the Oxychloride being so much in vogue. Hertz (9.) argues, and probably rightly, for his arguments are certainly most reasonable, that the Carbonate should not be used, but in its place the Oxychloride of Bismuth. He says that the sub-carbonate or carbonate is changed by the gastric juice into the oxychloride, and Carbon Dioxide is liberated. He adds, that with the large doses of Bismuth Sub-carbonate given for X ray investigation, the hydrochloric acid of the gastric juice is almost completely neutralized, and as a result gastric digestion is prevented, and the functions of the Pylorus which are largely controlled by the hydrochloric acid are upset.

In Germany and France the Sub-nitrate is largely used, and this undergoes a change in the stomach similar to that of the Carbonate, but Nitric acid is set free instead of Carbon Dioxide, and hence there is no diminution of acid in the stomach, and the functions of the gastric juice ought not to be interfered with. But cases of poisoning have been reported both in Germany and America when the Sub-nitrate has been used. In America E.G.Beck@W.Alexander, and L. Lewin, besides many others have reported cases of poisoning as a result of the Sub-nitrate. The poisoning may be due to impurities in the preparation; or the Nitric acid formed in the stomach, may be reduced in the intestines with the formation of Nitrites, and so poisoning would be inevitable if large doses of the Sub-nitrate were used. Hertz uses the Oxychloride which, he maintains, does not disturb gastric digestion; it can be given in large doses without fear of poisoning, and the drug is tasteless. In passing, I might mention that Bismuth Salts do not influence the Motor Activity of the Stomach mechanically.

I have, however, used the Sub-carbonate, and in defence of this drug I may say it has been used largely in America, the Continent and this Country, and the results of examination with this drug have not been at variance with the results of examination with the Oxychloride.

In theory one is bound to agree with Hertz's contentions, but he surely would not argue that all the work and results obtained with the Carbonate are valuless.

The patient then has his meal at 9 a.m. At 3 p.m., some six hours later, I examine him to see the results of the first bismuth meal. I have him stripped to the Pubis, and to accomplish this satisfactorily I always have my patients in pyjamas and not night shirts - one can fix a pair of pyjamas in position much more easily.

Position of the patient. I place him with his back and heels touching the table; I adjust the tube to the required level, switch off all lights, and start the X ray current. I use the fluorescent screen for examination in all cases. The screen should be pressed firmly against the abdomen when examining the stomach. The observation of the picture on the screen is far more important than Rontgenography i.e. the taking of a photograph. The photograph reveals only one single short phase of the functionating stomach. To one who has studied the changes in the gastric outline during peristalsis, it is clear that the single picture is of no elemental value. Bioroentgenography, or the moving X ray picture, while approximating the fluoroscopic values, is too expensive to be practical, and the

technique is exhausting, and liable to extrinsic errors. A photograph is only necessary for ensuring a correct diagnosis in doubtful cases and for a permanent record in the absence of a tracing. Cinematographic and instantaneous radiographs show more detail in the Regio Pylorica than can be made out on the screen. Radiographing gastric cases is an expensive luxury and most unnecessary as a rule.

1st Bismuth meal. This gives information as to the motility of the stomach, and gastric digestion. The average time required for the stomach to empty itself is from 2 to 4 hours. At the end of 6 hours there ought to be no bismuth remaining in the stomach. But, as the bismuth falls to the most dependent part of the stomach, some of it is bound to adhere to the mucous walls of the stomach long after the food has passed into the intestines, but the shadows thrown by such small traces of bismuth are quite negligible, and are overlooked by an experienced Radiographer.

2nd Bismuth meal. This meal has the same composition as the first and is administered some 6 hours after the first one. I give the patient the mug to hold, and switch off the lights, and then direct him to take a few mouthfuls of the mixture, and I follow the progress of the food from the oesophagus till it

reaches the lowest part of the stomach. This may take a few seconds or several minutes. It is easy to see the food entering the stomach, cross the inner side of the "Magenblase" and enter at its lower border. Having made my deductions from the manner in which the food descends, the patient takes as much of the meal as is necessary in the particular case.

The second meal gives one information as to the size, shape, position, tone, and pesistalsis of the stomach. The size and position of the stomach are most satisfactorily examined when the patient is in the vertical position, as in the horizontal position the greater curvature is not clearly defined, the bismuth salt tending to gravitate to the most dependent part of the stomach. In the horizontal position, the most dependent part is the fundus, and Hertz rightly maintains, that if we examine the stomach by the X rays in the horizontal position, our results are no better than if we used the older method of percussion after introducing air or carbon dioxide. An additional reason for examining in the vertical position is that the stomach is called upon to do its work in the vertical position. And yet as Students we were in the habit of percussing the stomach when the patient was lying down, and were quite ignorant of the changes in shape and position of the organ when the patient moved into a vertical position. Percussion was valuable, but

mainly for the reason that one could determine the position of the fundus of the stomach.

(12) Dr William Russell of Edinburgh, has developed a method termed Succussion. It is only applicable if there are air and semi-fluid contents in the stomach. He says, by means of the Succussion wave he can determine absolutely the lower, and right border, as well as the fundus of the organ. In the hands of those who can carry out his method, it would appear to be valuable.

The landmarks necessary for making a screen examination are (1) the Ensiform and the lower costal margins (2) the Umbilicus and (3) the Iliac Crests. The Umbilicus, contrary to expectations appears to be a fairly well fixed point, except in people with fat and pendulous abdomens; but in this connection, I might refer to a paper by Marjory M. Johnson (13.) in which she points out, that there is marked individual variation in the position of the Umbulicus. She examined 1000 students of both sexes and concludes -

1. That the Umbulicus is situated approximately two-thirds of the distance from the supra-sternal notch to the pupic crest.

2. That this distance varies from more than three-quarters to less than two-thirds.

3. That when standing the Umbilicus is lower than when lying down, a difference more marked in women than

in men.

But for all practical purposes the Umbilicus as a landmark is satisfactory, and is considered such by most Radiographers.

In view of the unreliability of the umbilical landmark Alan Newton (14.) of Melbourne University employes a metal frame which serves to delimit the abdomen accurately by Addison's method. His findings however, do not differ very much from those who use the umbilicus as their landmark.

V

ANATOMY AND PHYSIOLOGY OF NORMAL STOMACH.

The Normal Stomach.

At the very outset of Gastric Radioscopy one is faced with an immense difficulty i.e. what is the normal stomach. The position and axis of the stomach have been the subject of much misapprehension, and the cause of this apparently was the fact that the position of the stomach was studied after death, when the diaphragm was in a position of complete expiration and the abdominal wall was either removed, or certainly completely relaxed, and in addition, the stomach itself was in a position of paralytic dilatation, and such vital attributes of the living working organ as tonic action and peristalsis were absent. In addition there was the effect of post-mortem softening and pressure. Many descriptions of the normal stomach have been given. Holzknecht describes it as being shaped like a cow's horn, the pylorus being its lowest point. Most authorities agree that it is roughly J shaped, but it is very rare indeed to find the pylorus as the lowest point, though in women (possibly as a result of tight lacing) one finds it more often that in men and children. The lowest point is more often 1½ inches from the pylorus than actually at the pylorus itself. The Fundus is pyriform and lies beneath the left dome of the diaphragm and always contains gas. The Cardiac orifice is just to the left of the middle line under the seventh left

Costal Cartilage. In the vertical position, the body is of nearly uniform width, and is situated entirely to the left of the middle line, and even the pylorus does not cross to the right side except after a full meal.

The body of the stomach is either vertical or passes very little to the right, and is separated from the pyloric part by the Incisura Angularis of His on the lesser curvature.

The pyloric part of the stomach consists of the pyloric vestibule, which is directed upwards as it passes to the right of the middle line, and the pyloric canal of Jonnesco, which is about an inch in length, and passes backwards, upwards, and to the right, its termination projecting into the Duodenum. As a result of the tonic contraction of the sphincter which surrounds the pyloric canal, the latter is normally empty even when the rest of the stomach is full.

Many people consider that the stomach is placed transversely across the abdomen; but this is an error as the cardiac orifice is deeply placed just to the left of the spine, whilst the pylorus is nearer the anterior abdominal wall; so the axis is obliquely placed, and directed from behind and to the left downwards, forwards, and to the right. The smaller curvature, and orifices, are nearly fixed, whilst the fundus and great

curve are capable of free movement.

Dr Maud MacNaughton[15] found that the infant's stomach was globular in form, and occupied a position just below the diaphragm. Almost invariably air was present. In some cases, she found a part of the pyloric portion lower than the pylorus itself. On growing older, the stomach elongates, and Barclay says, stomachs most nearly resembling Holzknect's definition are found in youths and men. In girls, after puberty especially, the stomach tends to beatonic, and to extend well below the umbulicus.

In the vertical position the greater curvature almost invariably reaches below the umbilicus; the lowest point of the stomach can be lifted 2 to 4 inches by voluntary contraction of the abdominal muscles, and it can be caused to drop by voluntary relaxation of these muscles.

Normal stomach in vertical position.

It is important to compare the stomach in the vertical and in the horizontal position. In the standing position the stomach is well below the umbilicus, and

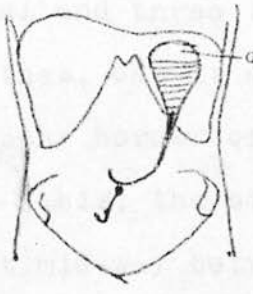
generally speaking the food is in the lower portion, and gas in the upper. In the lying position, the lower part of the stomach rises to the level of, or above the umbilicus, the food is spread over the back of the organ generally and the "Magenblase" is no longer visible as the air is spread out in front of the food. This shows the fallacy of trying to make out the position of the stomach in the lying position only.

It is really very questionable whether there is a true normal shape for the stomach, but it is certain that in the vertical or standing position the stomach itself is also nearly vertical, and almost or entirely to the left of the middle line of the body. It is also certain that the pylorus is not a fixed point except possibly, in the absolutely normal position.

The work of Jonnesco, Erik Muller and Cunningham on the Anatomy of the Pylorus is of great importance. They have shown that there is a definite tubular portion of the pyloric end about 3 c.m. in length which has been called by Jonnesco the pyloric canal. It makes a sharp angle with the pyloric vestibule, as it passes backwards and slightly upwards and to the right in contact with the quadrate lobe of the liver. It is relatively long in infants, and in them its separation from the pyloric vestibule is sharper than in Adults. Its termination

projects into the duodenum, producing, as Cunningham says, a very striking resemblance to the portio vaginalis of the cervix uteri. Both the circular and the longitudinal muscular coats are much thicker in the canal than in any other part of the stomach. The circular fibres are disposed in the form of a sphincter, which attains its greatest development at the duodeno-pyloric junction, where it is separated by a distinct connective tissue septum from the circular coat of the duodenum. Only a few of the more superficial longitudinal fibres are continuous with those of the duodenum, the majority forming distinct fasciculi, which penetrate the substance of the sphincter, in which some end, whilst others reach the subjacent submucous tissue. Groedel (16.) says "of late years there has been much discussion as to the normal form of a stomach filled with the Reider meal. Reider himself said that the stomach had the form of a fish hook. Holzknecht has maintained that the more rare but only normal form of stomach, is that of a cow's horn. I myself, after having examined a number of persons with healthy stomachs, have found the Reider form to be the normal one, and from its function have termed it the syphon form. It is the syphon form which permits most easily the letting off at will of the properly prepared food into the intestines."

Grodel further emphasises the following points - Beneath the diaphragm one sees the "Magenblase". It is clearly marked by a horizontal line against the shadow of the bismuth food. One can distinctly follow the course of the greater and smaller curvatures. In its entirety the stomach has the form of a hook almost uniform in breadth; one sees a long descending part, and a shorter ascending part; towards the duodenum the stomach is bounded by a sharp clear line - the pylorus. In the empty condition only the pear shaped upper third of the stomach contains gas, the rest of the organ passing to the pylorus in the form of a collapsed tube, which corresponds in position to the lesser curvature of the full stomach



Empty stomach.

From what I have said above, it is evident, that percussion of the stomach, whether empty or full, can only give information as to the area occupied by the gas it contains, and this bears no sort of proportion to the size of the organ. Although it is possible by means of

auscultatory percussion to mark out a very definite area, which was formerly believed to be that occupied by the stomach, the X rays have proved that in reality it yields an even less accurate representation of the stomach than simple percussion (Archives of Rontgen Ray Vol: XV Number 4 p. 162)

Dr Alan Newton in the Australian Medical Journal August 10. 1912 (17.) writes an interesting and instructive paper. He carried out experiments on 60 healthy individuals. Instead of the usual umbilical disc he used a metal frame which marked the abdomen accurately by Addison's method.

Addison chooses four bony landmarks - the upper border of the Manubrium Sterni, the Symphysis Pubis, and the two Anterior Superior Iliac Spines. The trunk is then divided by three vertical and three transverse lines. Of the three vertical lines, one is median in position, and is drawn from the upper border of the Manubrium Sterni to the Symphysis Pubis; the others are lateral and pass through a point mid-way between the anterior superior iliac spines and the mid-line. The vertical line is then sub-divided into four equal parts by three transverse lines. The transverse lines are named from above downwards -

a. Trans Thoracic Plane.

b. Trans Pyloric Plane.

c. Trans Tubercular Plane.

He finds that in the erect attitude the position of the stomach is extremely variable. He described four different types and employed the following terms and gives the statistics -

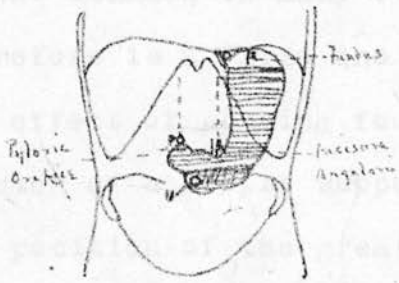
1.	Epigastric - - -	6
2.	Superior Umbilical -	13
3.	Inferior Umbilical -	27
4.	Hypogastric - -	14
		60

It will be seen that the Umbilical types preponderate, but that the stomach was frequently in the hypogastrium. The most rare type was the Epigastric - i.e. that which most closely conforms with the accepted anatomical description. He describes the normal stomach as J shaped. The vertical portion is situated in the left lateral line, and extends from the oesophageal opening in the diaphragm to the sharp angle in the stomach just above the trans-tubercular plane. At the junction of the upper two-thirds and lower one-third of this shadow , can be seen the constriction which when well marked gives rise to an appearance of hour-glass stomach.

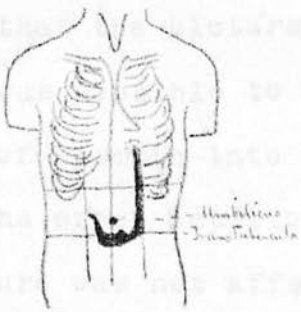
The Incisura Angularis is a deep notch situated at the angle of the stomach. The Pyloric Vestibule is just above, or just below, the trans-tubercular plane, and is always in a state of active peristalsis. The Lesser

Curvature is usually below the Umbilicus - i.e. the stomach is slightly lower than that described by Hertz as normal. The pyloric vestibule ascended to the pyloric orifice on the right side of the median line, and the pyloric orifice was situated in the right lateral line mid-way between the trans-pyloric and trans-tubercular planes in a large number of cases.

It is thus seen that the description is almost the same as Hertz's, but the stomach is placed somewhat lower by Newton.



Hertz.



Newton.

Newton found that in the horizontal position the stomach was situated at a higher level, the average ascent being $2\frac{1}{2}$ inches.

He found that it was difficult to arrive at a definite conclusion as to whether the position of the stomach had any relation to muscular development and physical type. It is probably true that, as a general rule, a thin tall atonic subject will be found to have a low

stomach, but it must be rembered there are frequent exceptions.
As regards sex he states "there is far more variation in regard to physical type than to sex. It was not found that males with low stomachs had a female type of pelvis."

Weight of Bismuth Meal. Newton says "it may be argued that the actual weight and high specific gravity of the bismuth was responsible for the low position of the stomach in many cases, and that the picture therefore is a false one .... It was possible to study the effect of placing four ounces of bismuth into the stomach of a corpse supported in the erect position. The position of the greater curvature was not affected by the weight of the bismuth. It must also be remembered, that stomachs found in the epigastrium contained exactly the same weight of bismuth as did those in the hypogastrium. Also, the bismuth meal weighs less than a normal meal of ordinary food stuffs, and it is when it contains the latter that the stomach has to exercise its function." Newton rightly calls attention to the fact that although in 14 individuals the stomach was in the hypogastrium, yet to all intents these persons were healthy individuals; he thinks, such ptosis is congenital in origin.
Barclay says "roughly speaking Holzknecht's description

holds good, the fallacy and difficulty however, being this - the stomach may be quite abnormal in shape and in its tone, and yet fulfil its functions in such a manner that no abnormal symptons are produced. It has in fact, no fixed shape, being a plastic organ - a hollow muscle lined by a mucous membrane."

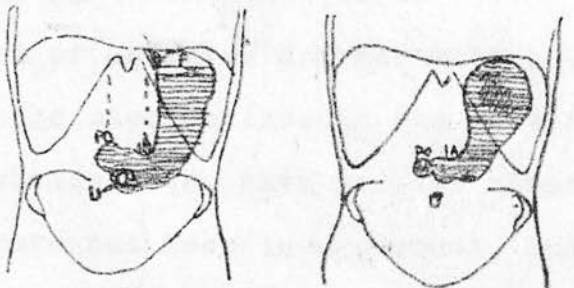
Summary of the Shape and Position of the Normal Stomach.

1. The Stomach is roughly J shaped.
2. It is almost uniform in breadth.
3. It is nearly vertical in position when the patient is examined standing.
4. In the vertical position, the fundus of the stomach is filled with gas, and is termed the Magenblase. In the empty condition only the pear shaped upper third of the stomach contains gas, the remainder of the stomach passing to the pylorus in the form of a collapsed tube which corresponds to the lesser curvature of the full stomach.

5. In the vertical position, as a rule, the lowest point of the stomach is below the Umbilicus. When the horizontal position is assumed, the greater curvature rises one or two inches, and comes to lie above the Umbilicus.

6. When empty the stomach is almost entirely to the left of the middle line; when full, the pylorus passes to the right.

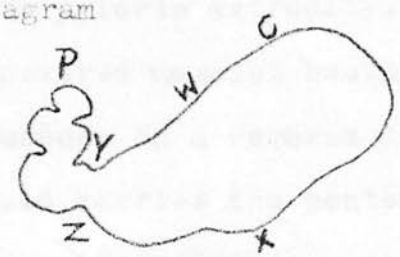
7. The stomach may be quite abnormal in shape, position, and tone, and yet give rise to no abnormal symptoms.



Movements of the Stomach.

Cannon (18.) was the foremost investigator of this subject by means of the Rontgen rays. Prior to his work, all observations had been made on pathological subjects, or on subjects subjected to serious operative interference. The only sure conclusion that could be drawn from these investigations, was the fact that when the stomach received food there were set up obscure peristaltic contractions, which churned the food, and finally forced it into the intestines.
The mixing of a small quantity of bismuth with the food, allows not only the contractions of the gastric wall, but also the movements of the gastric contents, to be seen with the Rontgen rays.
Examinations of animals, and men with gastric fistulae studies of the stomach through the atrophied abdominal wall, and vivisection, have yielded numerous results, but these have not been in agreement, and have led to much controversy. Beaumont's careful observation through the gastric fistula of Alexis St Martin are classical.
Cannon's method was to feed cats on 15 grammes of bread and milk, to which 5 grammes of bismuth sub-nitrate were added. He then observed the movements of the stomach by means of the X Rays and fluorescent screen.

He begins his description by locating the several parts of the stomach, and the following is the illustrative diagram



The Cardiac portion lies to the left of a line through W.X. Into it the oesophagus opens through the cardiac sphincter C. The pyloric part includes all the portion from W.X. to P. This part has two divisions - the antrum to the right of the portion Y. Z., and the middle region of the stomach between the lines W.X. and Y.Z. The lesser curvature corresponds, more or less, to the border C.W.P. and the greater curvature to C.X.P. Beaumont through a gastric fistula in Alexis St Martin, introduced a thermometer-tube, and noted how it was affected by movements of the stomach. His conclusions were, that the circular and transverse muscles contracted progressively from left to right. When this impulse arrives at the transverse band, this is excited to a more forceable contraction, and closing upon the alimentary matter, and fluids contained in the pyloric end, prevents their regurgitation. The muscles of the pyloric end, now contracting upon the

contents detained there, separate and expel some portion of the chyme. After the contractile impulse is carried to the pyloric extremity, the circular band and all the transverse muscles become relaxed, and the contraction commences in a reverse direction from right to left, and carries the contents again to the left extremity to undergo similar movements.

Rossbach used dogs for his experiments. He watched the stomach "in situ". When the stomach was full, he says he saw deep constrictions begin near the middle and pass in waves to the pylorus. The fundus remained in tonic contraction about its contents, and took no part in the peristalsis.

Cannon says "within five minutes after a cat has finished a meal of bread, there is visible, near the duodenal end of the antrum a slight annular contraction, which moves peristaltically to the pylorus; this is followed by several waves recurring at regular intervals." Shortly after this first movement, other constrictions appear near the middle of the stomach and course towards the pylorus. As new regions enter into the constriction, the fibres just previously contracted become relaxed, so that there is a true moving wave. Bayliss and Starling were first to show that excitation of any given point of the alimentary canal resulted in the production of a contraction above the point of excitation

and a relaxation below. The waves recur at regular intervals. After appearing first near the pylorus, they gradually move towards the left, and the constrictions appear to all start from the transverse band - that is to say a constriction about the middle of the stomach or commencement of the Pyloric Antrum.. This description will be seen to be practically identical with that described by Rossbach, but to be very different from Beaumont's account. But Beaumont's method of introducing a thermometer-tube into the stomach was obviously faulty, as the irritation of the tube was liable to produce abnormal contractions. Roux and Bathazard (19.) have carried out similar experiments to Cannons' on dogs and man, and have had results identical with the findings of Cannon. The movements of the Pyloric Sphincter were also investigated by Cannon with the X Rays. Rossbach says the pylorus is practically closed during the whole digestive period, and then the sphincter relaxes, and the peristaltic waves carry the contents onward. Cannon, in the cat, found that food entered the duodenum 10 or 15 minutes after the first constriction is seen in the pyloric part of the stomach, and each constriction after that does not necessarily force more food into the intestines as the pylorus may remain closed for a number of constrictions. He further found

that hard morsels of food kept the pylorus closed, and only escaped at the end of digestion.

The part played by the Fundus had not been appreciated till Cannon worked it out with bismuth meals. The fundus had been regarded as a place for peptic digestion, or a passive reservoir. In reality, it is an active reservoir, and in a state of tonic contraction, and from time to time it squeezes a portion of its contents into the antrum where the active movements described are proceeding.

Cannon says "the stomach is composed of two physiologically distinct portions - the busy antrum, over which during digestion constriction waves are running in continuous rhythm; and the cardiac part, which is an active reservoir, pressing out its contents a little at a time as the antral mechanism is ready to receive them.

Cannon summarises his findings in connection with the bismuth meal, and stomach movements as follows -

1. By mixing a harmless powder, sub-nitrate of bismuth with the food, the movements of the stomach can be seen by means of the Rontgen Rays.

2. The stomach consists of two physiologically distinct parts - the pyloric part, and the fundus; over the pyloric part while food is present, constriction waves

are seen continually coursing towards the pylorus; the fundus is an active reservoir for the food and squeezes out its contents gradually into the pyloric part.

3. The stomach is emptied by the formation, between the fundus and the antrum, of a tube along which constrictions pass. The contents of the fundus are pressed into the tube, and the tube and antrum slowly cleared of food by the waves of constriction.

4. The food in the pyloric portion is first pushed forward by the running wave, and then by pressure of the stomach wall is returned through the constriction ring - thus the food is thoroughly mixed with the gastric juice and is forced by an oscillating progress to the pylorus.

5. The food in the fundus is not moved by peristalsis, and consequently it is not mixed with the gastric juice; salivary digestion can therefore be carried on in this region for a considerable period without being stopped by the gastric juice.

6. The pylorus does not open at the approach of every wave, but only at irregular intervals. The arrival of a hard morsel causes the sphincter to open less frequently than normally, thus materially interfering with the passage of the already liquefied food.

7. Solid food remains in the antrum to be rubbed by the constrictions until triturated, or to be softened

by the gastric juice, or later it may be forced into the intestines in the solid state.

8. The constricting waves have therefore three functions - the mixing, trituration, and expulsion of the food.

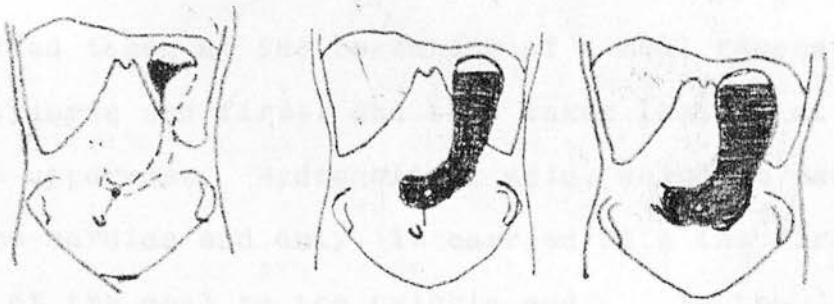
9. At the beginning of vomiting the gastric cavity is separated into two parts by a constriction at the entrance to the antrum; the cardiac portion is relaxed, and the spasmodic contraction of the abnominal muscles force the food through the open cardia into the oesophagus.

10. The stomach movements are inhibited whenever the cat shows signs of anxiety, rage, or distress.

Movements of the Stomach in Man.

Filling of the Stomach. The empty stomach appears to be a flabby, folded tube, and cannot be reproduced by the Rontgen Rays. We can see the "Magenblase" which is the highest point of the stomach. The first morsels of food appear as dark shadows at the bottom of the "Magenblase". These morsels remain here for a short time, and then slowly glide down the tube. The next morsels move on more rapidly and the food collects at the bottom of the stomach, and it soon fills up the whole stomach which becomes visible in all its parts.

Should more food be taken the different parts of the stomach expend at the sides, the length or height of the stomach not being affected. Thus the bismuth fills the stomach in a uniform way to the highest point, and the whole meal doe not fall and collect in the most dependent parts of the stomach.
The following diagrams illustrate these points -



(1) (2) (3)

(1) Normal stomach empty. Bismuth beginning to enter.
(2) Normal stomach with more bismuth.
(3) Normal stomach filled with bismuth - the pars pylorica is not quite filled.

As there is no anatomical division between the two parts of the stomach, diffusion of the saliva, and the soluble constituents of the food on the one hand, and of the gastric juice and the products of gastric digestion on the other, must, to some extent, take place. Respiratory movements produce some mixing of the gastric

contents, which can also be seen to be churned by strong contraction of the abdominal muscles. Moderate exercise, by increasing the abdominal and respiratory contractions, would cause the upper and lower parts of the stomach to be mixed together to some extent. Lying down has a similar effect. The heavier food tends to sink to the most dependent part of the stomach and lighter food rises to the surface.

The food taken at the beginning of a meal reaches the pyloric end first, and that taken last is at first uppermost. Hydrochloric acid, which is secreted by the cardiac end only, is carried with the first part of the meal to the pyloric end. In the pylorus the food and gastric juice are being constantly mixed by peristalsis. But there is a constant mixing of the pyloric and cardiac contents by diffusion, movements of the diaphragm and abdominal muscles, and the general movements of the body as a whole.

Barclay (.2a.) relates and illustrates the movement of the stomach as follows - "a patient who possessed a normal stomach took a small quantity of bismuth food. The bismuth gave the appearance in fig. (6a)

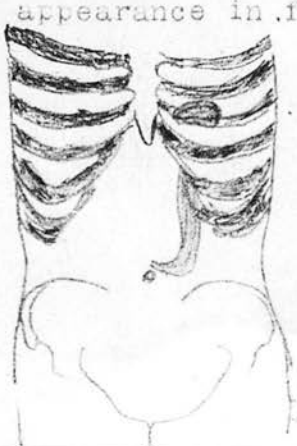


Fig. 6.a.

He then took a moderate meal of ordinary food. The appearance obtained was as you see in fig. (6b) the bismuth mixture being all at the bottom of the organ, while the ordinary food was invisible

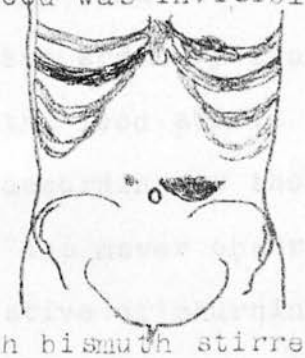


fig 6.b.

A cupful of milk with bismuth stirred up in it was administered, and as this entered the stomach it rapidly outlined the whole contents fig. (6c) as though a curtain was drawn over them.

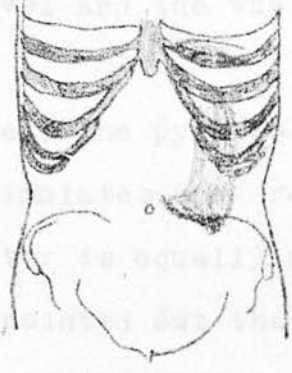


fig. 6.c.

As one watched in a few minutes, the ordinary food became invisible again, and there was a fairly definite line of division between it and the bismuth food below. There was no appreciable mixing of the food; the heavier was at the bottom and it remained there. Moreover, the liquid swallowed apparently flowed all round the mass of the food and down to the pylorus unobstructed. I think from this and other experiments, that fluids can pass at all times from the cardiac

orifice, round the food mass to the pylorus.
Do foods mix in the stomach? If bismuth food is taken after an ordinary meal, we see the former pass into the stomach and quickly find its way, either through or past the side of the ordinary food; it is simply the law of gravity, the food stuffs in the stomach taking up positions according to their specific gravity" Barclay adds that he has never observed anything in the normal stomach suggestive of churning, and he thinks that foods pass to the pyloric antrum in the order in which they are taken unless a heavier food follow a lighter, in which case the heavier food would sink until it found its level and the whole is bathed in gastric juice.
What occurs at, and near the pylorus, is difficut to ascertain and what stimulates and regulates the opening of the pyloric sphincter is equally difficult to ascertain. Bayliss and Starling pointed out that acidity in the duodenum closed the pylorus, but that acidity on the stomach side opened it.

Peristalsis.

Peristalsis in the normal subject does not appear to be a forcible movement. It is a very variable quantity, and influenced by various factors - the

character of the food, the patients emotions etc. Tonic action and peristalsis are quite distinct from one another, for perfect tone may be present when peristalsis cannot be elicited, and there may be good peristalsis in a stomach with very poor tone. Peristalsis is usually made out whether the patient is lying or standing. The waves appear to start on the greater curvature, near the junction of the middle and upper one-third, and to pass in wave like motions towards the pylorus - in this respect at any rate the movement is similar to that described by Cannon. Hertz's views are as follows - eachperistaltic wave as it approaches the pylorus deepens, and about an inch from the entrance to the pyloric canal it may deepen to such an extent that part of the pylorus becomes almost completely separated from the rest of the stomach. The part of the pylorus thus cut off diminishes in size as the peristaltic wave progresses, as a result there is some chyme forced through the pylorus into the duodenum, and the remainder of the contents are forced back as an axial reflux into the stomach. The waves increase in strength as digestion proceeds, and continue without intermission from immediately after the commencement of a meal until the stomach is empty. Endlemann thought that HCL stimulated peristalsis, and believed that the peristalsis was proportional to the acid present, the activity of peristalsis also

depends upon the food. The stretching of the muscular coat of the stomach by the entry of food is probably the chief stimulus to its activity (Ducceschi) The mere contact of smooth objects with the gastric mucous membrane has no effect, but irregularly shaped objects, especially if they are hard, without doubt stimulate peristalsis. The activity of peristalsis thus varies with the consistence of the food which reaches the stomach.

This description is very like that of Cannons for mototility of the stomach in cats and the movements related by Hertz are certainly, more or less, churning movements.

The pylorus has a nervous reflex mechanism of its own, and the sphincter relaxes on the arrival of each peristaltic wave. It requires some force to press the contents through the pyloric sphincter into the duodenum, and this is brought about by the waves becoming deeper as they approach the pylorus, and thus the intra-gastric pressure is greater at this portion of the stomach than elsewhere. The relaxation of the pyloric sphincter may be inhibited by certain influences. Pawlow said the presence of hydrochloric acid in the duodenum was such an influence, and Cannon says substances which might injure the duodenum in virtue of their properties whether thermal, mechanical,

or chemical, also inhibit the opening of the pyloric sphincter. When the peristaltic waves for any reason are exceptionally strong they begin nearer the fundus than usual, and they cause an excessive rise in the internal pressure in the pyloric end of the stomach. Absence of relaxation of the pylorus, of course may be, and often is, organic. No peristalsis occurs in the fundus and upper part of the stomach, the muscular coat of which is much thinner than the pyloric part. The upper half acts as a storehouse for the food. It is in a condition of tonic contraction, and only relaxes as each bolus of food reaches it from the stomach. This constant contraction produces a regular diminution in its volume, and so food is doled out to the active pyloric part, in such a way that after the conclusion of a meal the contents of the latter diminish much less rapidly in volume than those of the former. The constant state of contraction maintains the tubular form of the stomach and counterbalances gravity.

Saxl and Muller (21.) suggest that this adaptation of the stomach to the volume of its contents results from a reflex which originates in the oesophagus during swallowing, and is conveyed to the stomach by the Vagus.

The nature of the mechanism by means of which the stomach adaps itself to the volume of its contents in such a way that the internal pressure remains constant, is more complicated than might be supposed.

Grutzner (22.) pointed out, that a mere relaxation of the tonic contraction of the muscular fibres of the stomach would be quite insufficient to account for the enormous variations which occur in the volums of the stomach, without any variations in the internal pressure. He suggested that a re-arrangement of the muscular fibres must simultaneously occur. Albert Muller proved this supposition to be correct by studying the stomachs of frogs when empty, and when full. A re-arrangement of the fibres was found to be an important factor, as in the contracted stomach of the frog, they are arranged in from fifteen to twenty layers, whereas in the full stomach the muscular coat consists of only two or three layers.

When an ordinary meal is taken by an individual lying on his back, or on his left side, it reaches the pylorus more slowly than in the vertical position. If only a small quantity is taken at a time, it causes the fundus to bulge, but does not even touch the entrance to the collapsed part of the stomach (Holznecht). Hence the very small meals often given to bed-ridden patients, remain in the fundus, unless the erect, or semi-recumbent position is assumed. Only when two or three such feeds have been taken, will sufficient material be present to reach the entrance into the body of the stomach. If the patient is unable to sit up, it is therefore better

to give meals of moderate size at intervals of a few hours, instead of frequent very small feeds.

Reider (.22.) quotes Holzknects description which is as follows - "The motor phenomena of digestion, as seen by Roentgenoscopy, are as follows. While there is no active movement to be seen in the cardiac portion of the stomach, the lower portion of the greater curvature exhibits deep contractions. These depressions travel towards the pylorus, gradually getting deeper during their passage, till they get their maximum depth at the Sphincter Pylori, a point three to four fingers breadth above the pylorus. The maximul point of depression is characterized by the length of time it remains in a state of tonic contraction, and by the fact that the contractions here are the most energetic of any part of the stomach wall.

Opposite to this deep constriction of the greater curvature appears a similar depression of the lesser curvature of almost equal depth. There is no movement of the lesser curvature visible in the upper part of its contour. Eventually, the depression of the smaller, and that of the larger curvature meet, so that, on the screen, there is a clear line between the shadow of the contents of the corpus, and of the antrum. Soon afterwards, the shadow of the antrum disappears, its contents being emptied into the duodenum by a process

of concentric contraction.

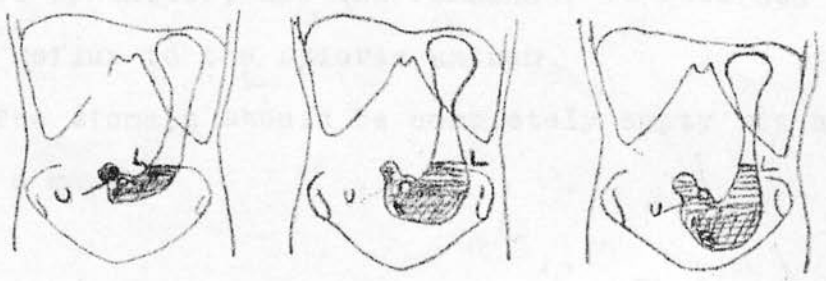
The constriction, three or four fingers breadth above the pylorus, mentioned above, has the effect of a sphincter antri, which periodically cuts off the antrum pylori from the body of the stomach. The circular constriction at this point is comprable in breadth, and extent with the pylorus itself. The button-like reduction of the antrum is brought about by a process of concentric contraction. It is doubtful however, whether there is a simultaneous peristaltic movement of the circular contraction towards the pylorus, or whether the circular depression remains stationary, and the evacuation is brought about by a contraction of the longitudinal fibres alone.

The above phenomena substantially correspond with the older observations made by physiologists and clinicians."

Tonic Action.

In a normal stomach, the upper border of the contents, should be about the level of the cardiac orifice. If more food is taken, the effect should be a widening of the tube - tonic action retains the stomach in its tubular form. It is an automatic contraction, and counteracts the effect of gravity on the food.
Atony is a loss of tonic action, or tone, and results in a falling of the lower border of the stomach. Tone is a property of living, healthy muscle , and is therefore absent in the port-mortem room. It is under the control of the central nervous system, and may alter very rapidly.

See diagrams -



Filling of the Atonic Stomach.

U - Umbilicus.

L - Upper limit of Gastric contents.

Summary of the Movements of the Stomach.

1. Food as it enters the stomach, is held up for a few seconds, in virtue of the tonic action of the stomach, and then glides to the most dependent part.

2. As more food is given, the stomach distends laterally, the tubular shape of the stomach being maintained.

3. The fundus acts as an active reservoir for the food; normally, no peristalsis takes place at the fundus.

4. Immediately food enters, peristalsis begins. This starts about the region of the Incisura Angularis, and runs in wave like motions towards the pylorus. The intragastric pressure in the region of the pylorus becoming raised, some food is forced out through the relaxed sphincter, and the remainder is returned by an axial reflux to the pyloric antrum.

5. The stomach should be completely empty six hours after a meal.

VI.

DISEASES OF THE STOMACH.

1. GASTROPTOSIS.

That the abdominal organs may be dislocated under certain conditions has been known for a long time.

(24.) Kussmaul was the first to call attention to a variety of changes in the form, and position of the stomach, and to point out the connection existing between these abnormalities and certain clinical symptoms.

Meniert (25.) demonstrated that Enteroptosis is by no means rare, and that it is commoner in women.

Glenard (26.) was the first to call attention to the frequent occurrence of anomalies in the position of the abdominal viscera, and to point out its clinical significance. He said the cause was a relaxation of the ligaments attached to these viscera.

The stomach alone is rarely dislocated, but other abdominal viscera are usually displaced at the same time.

Dislocation of abdominal organs, is naturally usually the result of pathological processes in the abdominal cavity; but a large pleural exudate on the left side may force the diaphragm downward on that side, and lead to a moderate degree of displacement of the organs in contact with the diaphragm.

Morbid processes that occur in the abdominal cavity, and lead to enlargement of different organs cause dislocations, and changes in form of other organs, particularly the stomach.

The effect of tight lacing is to compress the lower part of the thorax, and this may be a cause. Abnormal distention of the stomach itself, which persists for some time, may cause it to be displaced. A common cause of dislocation, and change in the form of the organ, is found in certain inflammatory processes, and adhesions with neighbouring organs that form as a result of these inflammations. Such changes are seen in Carcinoma, and adhesions following peritonitis. Carwardine cites Pericolitis as a cause.

Gastroptosis is found in adults of both sexes, chiefly in chicken breast, in funnel breast, in cases where the diaphragm or liver is dislocated downwards, and in cases where the liver is enlarged.

Stiller found that Gastroptosis was frequent where there was present a floating tenth rib.

Strauss (27) describes Gastroptosis etiologically into two classes. The first depends upon anomalies of body formation, and the second depends upon local mechanical causes. The majority of cases belong to the first group, and in such individuals, he believes, there is a characteristic formation of the thorax, and pelvis - in other words a natural predisposing condition. The fact is, that in many of these cases, there is a congenital delicacy or fragility of tissue, which, under strain, and in the absence of support, yields,

and the viscera easily becomes displaced.
Dislocation of the stomach is therefore usually acquired, and is due chiefly to the change in the normal arrangement of space in the lower half of the thorax, and the upper portion of the abdominal cavity. The stomach and other abdominal viscera must adapt themselves to these changes, and to this decrease in the normal amount of space placed at their disposal, and are consequently forced to move in the direction of least resistance, and to take up a position wherever they find room.

Gastroptosis is a dislocation of the stomach downwards. Strictly speaking, we rarely find the whole stomach displaced downwards, for the organ is fixed at its cardiac end, and it is usually the pylorus alone that falls. The fixed point is usually situated in the region of the twelfth thoracic vertebra, and this portion of the organ usually remains in contact with the disphragm, even though the rest of the stomach is dislocated.
Of course, if the stomach is heavy and dislocated downward, this portion of the organ may also be forcibly pulled from its normal position. All other portions of the stomach however, are freely movable, and can easily change their position.
In determining the abnormal position of the stomach, it is important to locate the lesser curvature, and the pylorus; it is only when the latter portions of the

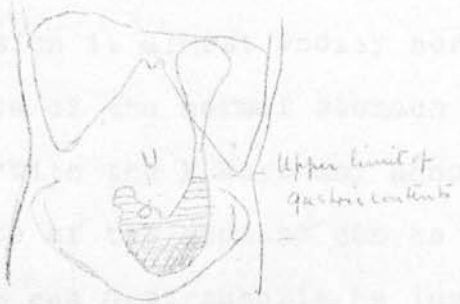
stomach are displaced downwards that we can truly call the position Gastroptosis. The greater curvature may be very low down in any stomach that is abnormally large but still in its normal position.
In considering the question of Gastroptosis, the observations of Pfahler are important. He found that the lower pole of the stomach could be lifted considerably by a voluntary contraction of the abdominal muscles, and could be caused to drop by their voluntary relaxation. Hertz found that the lowest point of the stomach could be raised 5 to 13 c.m. by a voluntary effort. Thus, great relaxation of the abdominal walls may lead to Gastroptosis.

With regard to the diagnosis of this condition, X Rays is all important. All that is done, as a rule, in examining stomach cases is to determine the position of the greater curvature, and this is useless in such a condition. A dislocation of the stomach downward can only be diagnosed by finding the position of the pylorus, and lesser curvature, and by the methods of palpation and percussion this is impossible.
With the X Rays, however, one can watch the food entering the stomach, can see it filling the stomach, and can determine the position of the fundus, greater curvature and lesser curvature, and the pylorus.

In most cases of Gastroptosis, there is atony as well. The lower part of the stomach drops deeply, and low down in the abdomen. The body of the stomach becomes stretched, and its lumen practically obliterated if it becomes over stretched.

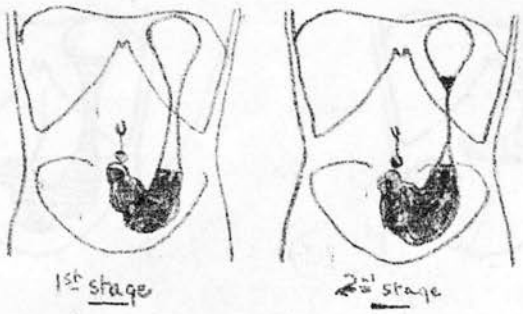
On watching the meal entering the stomach, it first collects for a short time below the "Magenblase" and then passes down in a thin stream through the stretched part of the body of the stomach and finally collects at the most dependent part.

Diagramatically -



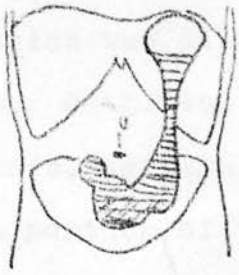
If the body of the stomach is stretched so far that the lumen becomes obliterated, a condition of hour-glass stomach is simulated. On administering the bismuth food, most of it passes down into the dependent portion of the stomach, but a small quantity is held up just above the occluded body of the stomach, and the following appearance results -

See diagram on next page.

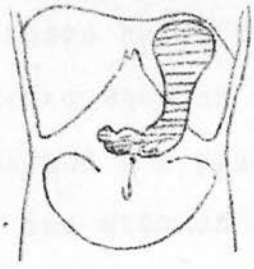


Hour-glass stomach as result of Gastroptosis.

It would be observed that in Gastroptosis the shadow cast by the emulsion is almost wholly horizontal, and the vertical shape of the normal stomach abolished. Hertz (29.) says "With the X Rays any abnormality in the position and shape of the stomach can be readily observed. By no other means can Gastroptosis be invariably diagnosed with certainty, for in many cases in which the stomach is quite normal in position when the patient lies down, as he does for ordinary abdominal examination, it drops to a remarkably low level as soon as he stands up. I have been struck by the fact that severe gastroptosis is not un-common in individuals whose abdominal muscles are well developed, and whose other viscera do not appear to drop excessively when the erect posture is assumed"



Vertical.



Horizontal.

Ptosis of an otherwise normal stomach disappearing in the horizontal position.

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(30) Dr Harrison Orton says that if a patient with gastroptosis is examined in the erect position the bismuth is seen low down in the pelvis; but on putting the patient on his back the whole stomach should drop back, and the bismuth be seen above the umbilicus.

It has been noted that patients with gastroptosis are frequent sufferers from dyspeptic symptoms and a variety of nervous, hysterical, and neurasthenic disturbances. E.M. - female - aet. 18. was such a case. She had globus hystericus, tacchycardia, pains in diffuse areas of the abdomen, and vomited after everything taken. She had actually been washing out her stomach daily with a stomach tube, and from time to time lived on nutrient enemas. She had her stomach X rayed.

At the end of six hours after the 1st bismuth meal there was a considerable residue remaining in the stomach which was dilated, and ptosed below the umbilicus. On giving a 2nd meal the stomach was found to be atonic, peristalsis feeble, and the pyloric end and a portion of the body of the stomach dislocated. She was put on a modified Weir Mitchell treatment and improved to some extent.

L. J. - female - aet. 24. has gastric and nervous systems. Her stomach was gastroptosed and appeared to be almost on a level with the Symphysis Pubis. Both these cases were in females, and in both there were marked nervous symptoms.

To make out the lesser curvature it is necessary to give the patient a full meal. If the stomach is atonic, the food will gravitate to the most dependent part, and will distend the stomach without filling it. The greater curvature will become lower and lower, but the lesser curvature will remain obscure. Thus in gastroptosis plus atonic dilatation we can only say there is dilatation of the stomach with dropping of the pylorus.

Summary of Gastroptosis.

1. The greater curvature is considerably below the umbilicus.

2. The pylorus is displaced downwards.

3. The pylorus and lesser curvature require to be seen to distinguish the condition from an ordinary dilated stomach.

4. The stomach loses its vertical character and becomes almost horizontal.

(See Case 4. Plate 3.)

2. HOUR-GLASS STOMACH.

This condition may be congenital or acquired - more often it is acquired. The stomach assumes a peculiar sacculated outline, and is divided into two parts - a cardiac and a pyloric sac. In some instances the cardiac sac is larger, in others the pyloric one. For a long time hour-glass stomach was thought to be nearly always congenital, but Moynihan has shown that it is almost invariably due to Gastric Ulcer. The ulcer, which is generally placed at the lesser curvature, and extends into the anterior and posterior surfaces of the stomach, gradually contracts and draws the greater curvature upwards. Adhesions also form to the under surface of the liver, to the anterior abdominal wall, or toward the spine. These may drag upon and narrow the stomach. Carcinoma also causes the condition, but this is probably secondary to a simple ulcer. Spasm of the muscle often plays a part in its production, indeed the condition may be purely functional.

Diagnosis. The history would not give this, and there were a number of signs used previously, which however, were all open to fallacy. The best known tests are the following -

1. If a stomach tube be passed, and the stomach washed out with a known quantity of fluid, the loss of a certain quantity will be observed when the return fluid is measured.

2. If the stomach be washed out until the fluid returns clear, a sudden rush of foul, evil smelling fluid may occur; or if the stomach be washed clear, the tube withdrawn, and passed again in a few minutes, several ounces of dirty offensive fluid may escape. The fluid has regurgitated through the connecting channel between the pyloric and cardiac pouches.

3. If the stomach be palpated and a succussion splash obtained, the stomach tube passed, and the stomach apparently empty, palpation will still elicit a distinct splashing sound. This is due to the fact that only the cardiac pouch is drained; the contents of the pyloric remain undisturbed, and cause the splashing sound on palpation.

The above tests are of value, but no reliance can be placed on a negative result. Positive results are certainly of value, especially the escape of turbid fluid through the tube after the stomach has been apparently washed clean. But it is obvious that positive results cannot be expected from these tests if the constriction is at all tight; and these are the

very cases in which a prompt diagnosis is most important.

The bismuth meal and X Ray test, if carefully applied, is reliable, and is by far the best clinical method of finding out if there is, or is not, hour-glass contraction. It also serves to show if there is pyloric obstruction as well, for in the absence of this complication the bismuth passes from the pyloric pouch into the intestines in a natural way.

X Ray appearance of Hour-Glass Stomach.

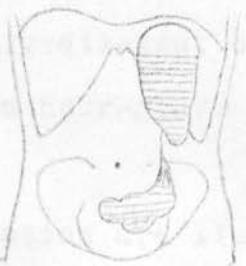
The bismuth is held up in the upper sac, and one may note retained food. The lowest point of this sac will be seen to be considerably above the umbilicus, and shows no indication of turning to the right as if towards the pylorus. On watching, one generally sees some portion passing on in drops, or as a thin pencil, and falling into the lower sac. If nothing passes from the upper sac, the patient should be given more of the bismuth meal, and this is often sufficient to raise the intragastric pressure, and force a passage into the lower sac. The appearance presented is somewhat like the following diagram -

The distinction between functional and organic hour-glass stomach is important, and the following points help in a decision -

1. If, on rubbing the patient's abdomen, it is found that the greater part of the shadow has decended into the lower sac, the condition is certainly spasmodic; but if rubbing the patient's abdomen makes little or no difference in the rate at which the food leaves the upper sac, a true organic hour-glass condition is almost certainly present; and on careful examination of the upper sac peristalsis can be found on the greater curvature, starting almost under the diaphragm - that is to say much higher than usual.

2. In spasmodic hour-glass stomach the neck passes from the most dependent part of the upper sac.

Spasmodic.



Organic.

(See photographs of hour-glass stomach at back)

In the lower sac the food may show a variety of pictures, but most frequently the shadow is well below the umbilicus, and both atony and pyloric obstruction are present. (See Plate 7.)

Hour-glass contraction has been diagnosed when a subsequent operation has shown that the condition does not exist. Hertz (51.) thinks that the mistake is due to the weight of the bismuth in the lower part of a dilated and dropped stomach. This drags upon and narrows the middle part of the stomach, giving it an appearance somewhat like an hour-glass stomach. If a patient with dilatation of the stomach and gastroptosis be examined with the screen while taking the bismuth, the latter can be seen passing immediately into the lower part of the stomach, whereas with hour-glass stomach the bismuth takes a long time to reach the pyloric pouch. And further, the dark line joining the two shadows passes from the lowest point of the upper one when the stomach is merely dilated, but from the right border when there is true hour-glass contraction.

Cases of extreme hour-glass contraction are liable to be overlooked, as food may not pass into the lower pouch, for some time. When the bismuth meal has been taken the upper division of the stomach is clearly visible in the vertical position, but its lowest point does not reach the level of the umbilicus, and this, therefore

indicates an abnormality. The history and symptoms of the patient probably point to pyloric obstruction, yet the stomach may be found to be very small instead of large. In such a case a tight hour-glass stricture should be suspected at once. In these doubtful cases, more than one screen examination should be made, and certainly one should examine the patient six hours after a bismuth meal, as by this time sufficient bismuth will have reached the lower portion of the stomach for it to be visible, and in some cases a fine line may be seen joining the two portions together.

(See photographs at back)

Summary of Hour-Glass Stomach.

1. Hour-glass stomach may be Congenital or Acquired, the acquired being either of an Organic or Spasmodic nature.

2. By clinical methods it is extremely difficult to diagnose the condition, and clinical findings are open to great fallacy.

3. The appearances in X Ray are typical, and the occurrence of two masses of bismuth, connected by a thin irregular pencil shadow, are conclusive of organic hour-glass, whilst massage of the stomach, and examination in the horizontal as well as vertical position, will show the condition to be one of spasm

3. DILATED STOMACH.

Dilatation of the stomach results from a failure of the muscle to maintain the tubular form of the organ against the action of gravity, and may result from a variety of causes of which the following are some -

1. Over-feeding, either as the result of persistent over-loading of the stomach constantly over taxing its capacity; or the taking of food too frequently, so that a fresh meal is introduced into the stomach before the previous one has had time to leave it. Insufficient mastication, and the bolting of lumps of food are also causes, the pylorus closing to prevent the passage of lumps out of the stomach.

2. Pyloric spasm of reflex origin - the cause of dilatation in these cases is not located in the stomach, and it may result from such causes as the following -

   a. Appendicitis - one frequently gets a long history of "dyspepsia" in cases of appendicitis.

   b. Gall stones (See case A. B. No 22)

   c. Renal calculi, uterine and ovarian irritation.

3. Overwork, worry, irregular hours, lack of exercise etc causing lack of tone in the muscle itself.

4. Organic obstruction of the Pylorus. (I discussed this under a separate heading)

X Ray appearances. In the mildest degree of dilatation the food is held up for a short time, and then gradually gravitates to the lowest part, and there is always some evidence of the tubular formation remaining even after a prolonged period; in marked cases of atonic dilatation the food straightway gravitates to the lowest part, and it is only the lowest border that is outlined. The food finds its level in the lowest part, forming a more or less cresentic shadow, low down in the abdomen, and in extreme cases even on a level with the pubes. If the patient takes more of the meal, the increased capacity is obtained not by a widening of the tube as it should be normally, but by an increase in the vertical depth. In fact the stomach does not contract upon its contents but remains inert. The upper limit of the food, in a normal stomach, is usually one or two inches below the diaphragm; in a dilated stomach the greater curvature of the stomach sinks more and more deeply, and the upper level of the contents is considerably below the diaphragm.

I have illustrated below the method of filling of the atonic dilated stomach -

It is important to remember that the stomach may be abnormally large or distended and still possess normal motor powers; or it may be normal in size, and yet be deficient in motor action. Atony and motor insufficiency are, therefore, two distinct conditions. Atony signifies relaxation; it is not correct therefore, to consider atony and motor insufficiency as identical. In Stenosis of the Pylorus the motor powers of the stomach are insufficient - i.e. the motor power of the stomach is not sufficient to propel the ingesta from the organ within the normal time. But this does not mean that Atony is present; on the contrary, the musculature in many cases is hyperprophic, but nevertheless incapable of performing its normal tasks, and is consequently insufficient; atony, in other words, is a peculiar form of motor insufficiency produced by relaxation of the muscularis. At the same time in Pyloric Stenosis, although the musculature is probably hypertrophied, there may still be dilatation of the stomach, and motor insufficiency, and atony. In true atony we deal with an absolute primary loss of muscle power; in a case of pyloric stenosis one has hypertonicity to start with, but this may end in atonicity.

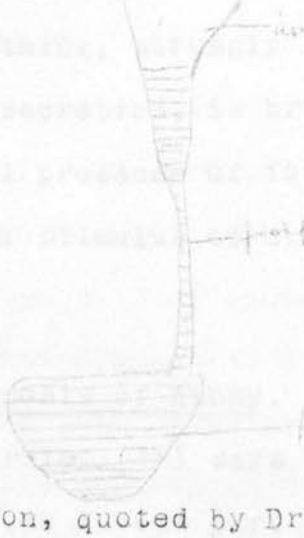
The fact that the lower border of the stomach is below the umbilicus, is no proof that there is atony present -

the stomach may be gastroptosed. To diagnose atony one must administer a bismuth meal, and watch its behaviour during the time it is entering the stomach. At the end of six hours after the bismuth meal, the stomach ought to be empty. If an appreciable amount of the meal remain one has either obstruction to the outlet of the food, or else one has to deal with a case of atony. Peristalsis is present in almost all cases of atony, and peristaltic action is apparently entirely independent of the muscular tone of the walls of the stomach.

Barclay (32.) describes an interesting experiment to prove the effect of atony on the stomach and its contents. He removed, what was apparently a normal stomach, after death. He suspended it by the oesophagus, and along the line of the gastrosplenic omentum, and filled it with an ordinary meal of bread and milk. He then passed some bismuth mixed with food through the oesophagus, and it naturally fell to the bottom of the sac, which stretched 2½ inches under the weight of the food. The bismuth ran down the lesser curvature, displaced the liquid constituents, and found its way through the bread and milk. This was simply a matter of specific gravity. The experiment on the dead stomach was of value in showing what is meant by a toneless stomach.

I reproduce his illustrative diagram below.

(33) Barclay also illustrates a case where the food passed straight down to the lowest point almost exactly like that seen in the dead stomach -



He further says "Ageron, quoted by Dr. Hutchinson, thinks that atonic dilatation is due to a failure of the reflex contraction of the stomach upon the food, thus allowing the fluid pressure of its contents to exert its distending effect unopposed. Some light is thrown on this by a number of cases I have seen, but especially a lady aged 33, who is thin and muscular, with a strong abdominal wall, in whom the lower border

of the stomach extended to 4½ inches below the umbilicus. It contained very little air, and failed to contract on the food as it entered and ran down to the lowest point. Her symptoms are occasional discomfort after food and palpitation, the latter condition being brought on when eructation takes place, and is invariably relieved by bending down. She has never suffered from any illness since childhood, and has always lived an energetic life. She still speaks of the loathing with which she endured the enforced porridge regime of her school, and is indifferent to food at the present day. These cases, I think, strongly suggest that tonic action, like gastric secretion, is brought into play not only by the actual presence of food in the stomach, but also by the mental stimulus of the appreciation of the food."

Fallacies in the diagnosis of Atony.

Under this heading Barclay (33.) says "that the bismuth shadow only outlines the lowest part of the stomach' after a time, does not necessarily indicate loss of tone, for it must be remembered that the stomach itself will be secreting juice, which, being lighter than the bismuth food, will consequently rise above it. Hence, although the tubular form may be maintained, yet the upper part of the tube will throw no shadow, because it contains none of the bismuth mixture....

For the same reason an atonic condition is suggested when the stomach already contains food; the bismuth mixture rapidly sinks through the stomach contents, which cannot be seen, and hence only the lower border is outlined. The fact of a full stomach is always suggestive, however, before the bismuth food is given, by the shape of the air space, bounded below by the upper margin of the fluid. Also, when the bismuth food enters, it passes down more rapidly than when canalizing a passage between the collapsed wall, and in a manner that at once suggests a heavy substance falling through a lighter. Moreover, when a considerable quantity has been given, the shadow indicates that it is only the lower part of a column that we see, and further information on this point is easily obtained by pressing the stomach contents upwards. The lowest border of the stomach is well below the umbilicus in atony, but this is no proof that the stomach is atonic, for the whole stomach is displaced when the diaphragm is below its usual level. This condition - viceroptosis - is most important, as it gives rise to severe gastric symptoms in some cases.

Summary.

In the diagnosis of dilatation one has to note the following points -

1. Is the food "held up" for a short time after entering the stomach or does it immediately drop to the most dependent part?

2. On giving more food, does it expand the stomach, or does it drop and elongate the stomach, and lie as a mass at the bottom of the stomach?

3. Is the upper limit of the bismuth maintained at a constant level?

4. What is the position of the greater curvature?

5. How long does the stomach take to empty itself?

4. PYLORIC OBSTRUCTION.

This may be Congenital or Acquired. Congenital Stenosis occurs in children, and more rarely in adults (William Russell and Maylard) and gives rise to a series of symptoms and signs which are quite unmistakeable. But Stenosis is more often Acquired, and the most frequent causes of this lesion are - Cicatrices from ulcers; Carcinoma of the Pylorus; and Cicatrices following erosion of the mucous lining of the stomach by irritating substances than have been swallowed. Narrowing of the lumen of the duodenum may lead to obstruction in the same way as narrowing of the pylorus. Stenosis of the duodenum may be caused by ulcers, cicatrices following ulcers, carcinoma, compression of the duodenum from without, adhesions, and dislocation of the parts by traction. Acquired hyperprophy of the musculature of the pylorus is a less frequent cause of stenosis. Or the Obstruction may be spasmodic - as in hyperacidity and hypersecretion or in ulcer or gall stones etc.

Other rarer causes of stenosis of the pylorus are - benign tumours of the pylorus, pedunculated polypi, connective tissue hyperplasia of the pyloric region (linitis plastica) , occlusion of the pylorus by adhesions with neighbouring organs, tumours that press

upon the pylorus from without(e.g. large gall stones in the gall bladder), perigastric adhesions, adhesions with the gall bladder etc.

The degree of motor insufficiency varies in different cases. Sooner or later, the typical picture of dilatation of the stomach develops in most of these cases. The most severe cases of dilatation are seen in Stenosis of the Pylorus, but, as I have already mentioned, simple atony may lead to dilatation, but simple atony with dilatation differs from dilatation as a result of pyloric obstruction in the circumstance that in the latter one has hypertrophy of the stomach, whereas in the former the muscular wall remains thin and atrophic.

Some authors hold that floating kidney on the right side may cause dilatation of the stomach by pulling on the duodenum, and thus give rise to obstruction. But in these cases of dilatation, on X Ray examination it has been found that Gastroptosis is the accompaniment of the floating kidney - in fact, both the Gastroptosis and Floating Kidney are caused by some other factor.

Diagnosis by X Rays.

In the early stages of Pyloric obstruction the signs are as follows - if one examines such a stomach six hours after a bismuth meal, one finds that the whole

of the bismuth has not left the stomach - there is a residue. The stomach is perhaps a little dilated, the bismuth shadow appearing a little lower than normally. There is evident peristalsis.
If a second meal is given at such a stage in the disease there will be good tone in the stomach as is evidenced by the fact that the food is "held up" as it enters the stomach, and on a complete meal being given the stomach will not drop, but will expand laterally. Good peristalsis will be observed.

At a later stage when the Stenosis is almost complete, or absolutely complete, on examining the patient six hours after a meal there will be a very large residue - in fact the whole meal may be retained. The stomach will be considerably below the umbilicus. Peristalsis will be very active, or even violent, and an important point is that the peristalsis will be seen, sometimes, to start at the fundus which is quite unusual in a normal stomach. It is in these cases that antiperistalsis occurs. (I have an excellent illustration of this in the case A.A. No 11. Plate No. 11.).
The tone of the stomach may be good but more often it is defective, and if further food is given it shows no sign of being "held up" at the fundus for a short time, but drops straight down to the most dependent part of the stomach.

The proof of Pyloric obstruction is that the stomach still contains some of the bismuth meal longer than six hours, in spite of the presence of good peristalsis. Observations must therefore be made from time to time to see when the food leaves the stomach. If it is empty in 10 hours the condition is such that the patient can probably lead a comfortable life with careful dieting, but if there is still food in the stomach in 24 hours the condition calls for surgical interference. very frequent observations are not necessary since we can learn from the position of the bismuth in the intestines when the food probably left the stomach; for Hertz found that food should be seen in the Caecum in 4½ hours, at the Hepatic flexure in 6½ hours after leaving the stomach.

I have a number of photographs illustrating cases of Pyloric Obstruction. The points to be noted in my cases are -

1. Six hours after the bismuth meal there is a considerable residue in the stomach.
2. The stomach is dilated, and below the umbilicus.
3. In some cases there is evidence of peristalsis visible, and in one case evidence of antiperistalsis.

In pyloric obstruction one meets the most extreme cases of gastric dilatation. The dilatation may be so severe that none of the food taken at an ordinary meal

ever reaches the pyloric end of the stomach, so long as the patient is in the erect position.

Hertz (34) points out that"the activity of peristalsis can be readily demonstrated with the X Rays, and the complete independence of peristalsis and tone has only been recognised since this method of examination was introduced. Thus, normal peristalsis is frequently observed in atonic and dilated stomachs, in rare cases peristalsis may be deficient in hypertonic stomachs. In organic pyloric obstruction increased peristalsis can often be observed before it is visible through the abdominal wall, and instead of commencing in the middle of the greater curvature it can be seen to start near the fundus and to produce a complete separation of the contents of the pyloric end from those of the rest of the stomach at a point considerably more distant from the pyloric canal than is normally the case.

I have only once seen antiperistalsis in the stomach; when present it is a conclusive sign of organic obstruction".

In organic obstruction there is often severe pain. This pain commences soon after a meal has been taken, and increases in severity as peristalsis becomes more active, on account of the secretion of hydrochloric acid in non-malignant cases, and the formation of organic acids in malignant cases.

The increase in the tone of the stomach, which occurs as it empties itself, is an additional factor in the progressive aggravation of the pain, as it makes it possible for the powerful peristaltic waves to shut off the pyloric end of the stomach more completely. The pain may last for many hours, and in severe cases, in which evacuation by the natural passage is never complete, it is only relieved by vomiting or lavage. (Hertz. (35))

Peristalsis is a very important feature in organic obstruction and by means of the X Rays it can be demonstrated easily, whereas one had to depend on visible peristalsis before Rontgen diagnosis was established. It is frequently of the greatest importance to be able to decide whether a dilated stomach is due to an obstruction to the outlet, or to an atonic condition of the organ itself. In view of the fact that the operation of gastro-enterostomy is successful in the former condition, and so frequently fails in the latter, it would be of great benefit to the Surgeon to know if there is an actual stricture of the pylorus, and by the X Ray method described the question can often be settled.

Pyloric obstruction may be congenital and is not infrequently diagnosed in infants, and X Rays here are

also of value. Pisek and Le Wald (36.) discussed Pyloric Obstruction in infants, with a comparative study of the normal stomach, and indicate an additional means in X Rays towards an early establishment of diagnosis. From an X Ray study of normal stomachs in infants at varying ages fed with bismuth milk emulsions, with the baby in a vertical position, the natural contour of the organ "in situ" was found to assume varying forms. Liquid foods begin normally to be expelled from the stomach into the duodenum within a minute or two after injecting, and this fact is helpful in the diagnosis of conditions of pyloric obstructions. If it is possible by a series of bismuth radiographs to demonstrate accurately that milk is retained longer than would be the case in the normal stomach, it becomes possible to determine the type of obstruction. Thus cases of true tumour with so small a lumen as to practically occlude the passage of food into the duodenum would be operated upon while the general condition remained good, whereas in the case of spasm without tumour formation the time, and the amount of food passing through the pylorus, can be estimated, and thus the advisability of resorting to medical rather than surgical treatment determined. Every suspected case of pyloric obstruction therefore, should be studied radiographically before deciding what line of treatment is best.

CARCINOMA.

The question of Carcinoma is not very considerably aided by the X Ray examination. New growths in the abdomen throw no shadow, and one can only rely on some rather indefinite features.

A Carcinoma of the fundus causes an irregular invagination of the greater curvature.

The inroads caused by a growth may be quite small and give rise to very little irregularity in the bismuth shadow, and such irregularity may be mistaken for peristalsis. But on careful observation the irregularity will be seen to be permanent, and if a peristaltic wave can be detected, it will be observed passing to the notch, then disappearing, and re-appearing on the farthur side of the notch. In an advanced case a portion of the gastric cavity may be obliterated.

Growths may displace the stomach. I have three photographs of stomachs with growths at the Pylorus. The whole of the bismuth meal was retained after 6 hours and the stomach was displaced to the left. The bismuth shadow terminates abruptly as if it were suddenly cut short.

(See cases No 15, 16, 18 Plates Nos 15, 16, 17, 19)

Carcinoma of the Pylorus causes obstruction, but it is impossible, in most cases, to state whether the cause of the obstruction is benign or malignant. And here

it is that one is impressed with the fallacy of trusting to the Radiologist for more than a diagnosis of Pyloric Obstructions. It is only by combining the findings of the Radiologist with a chemical and microscopical examination of the stomach contents that one can hope to indicate the pathological cause of the obstruction. If the history, physical signs, and test meal are investigated, and then the Radiologist is consulted, the diagnosis is often successfuly made of Carcinoma.

Growths involving the posterior wall, may invade the stomach so that the bismuth is displaced, and a clear space is seen in the midst of the shadow.

Summary of Pyloric Obstruction.

1. Pyloric Obstruction may be Reflex, Simple Organic, or Malignant.
2. If after six hours a large portion of the bismuth meal is retained, pyloric obstruction is probable.
3. If peristalsis is well marked, pyloric obstruction is almost certain; if there is antiperistalsis, pyloric obstruction is certain.
4. If peristalsis is not well marked, it may still be a case of pyloric obstruction, but is probably not a suitable case for Surgical interference.

5. The presence of Carcinoma may be suspected from the irregularity of the bismuth shadow, but its presence can only be asserted by combining Radioscopy with Chemical and Microscopical findings.

5. GASTRIC ULCER.

A considerable amount of work has been done on the subject of Gastric Ulcer both in this Country and America, but the results, as a rule, are not convincing.

But one type of ulcer is often demonstrable by the Rontgen Rays - I mean, the deep penetrating ulcer on the lesser curvature, whose base before penetrating, becomes adherent to the left lobe of the liver anteriorly, or the pancreas posterialy.

The stomach, being an extremely sensitive organ, is subject to many causes of irritation which result in spasmodic contraction. Many of these contractions are, no doubt, reflex; others are functional; but undoubtedly Gastric Ulcer is the cause of definite spasmodic contraction which may even indicate the site of such an ulcer. These spasms contract the stomach temporarily, an d the food given is held up above the situation of the spasmodic contraction, but the spasm would suddenly relax and allow the food to pass on normally.

Barclay says "when the bismuth food is held up in the upper portion of the stomach it is always a good plan to get someone to rub the abdomen, and this very frequently relaxes the spasm so that the contents pass

down at once. When the tone of the whole organ is good, the resultant shadow is that of a normal stomach, with possibly a small indentation to mark where the spasm has occurred; but if the tone is defective as it usually is in these cases, the contents drop into the lower part, possibly leaving some traces at the point where the obstruction was noted. Further, abdominal massage usually causes the whole shadow to gravitate to the lowest part, but if traces are observed for a considerable time, in spite of massage and a drink of milk, it is almost certain that there is definite ulceration or cicatrisation at this point, giving rise to spasm. Such are the pictures of spasm in the middle portion of stomachs of normal and deficient tone. These may be due to an ulcer, but apart from the evidence of traces left about the ulcer after the upper part of the stomach is emptied, the diagnosis is one of a spasmodic condition, which may, or may not, be due to ulceration."

These spasmodic conditions are not only found in the middle portion of the stomach, but may occur at the pylorus - in which case there is pyloric obstruction - , or at the cardiac end of the stomach with resulting oesophageal obstruction.

Harry Adler and Howard Ashbury (37.) record their results of investigations on X Ray diagnosis of gastric ulcer.

The principle of their method of demonstrating ulcers by the X Ray method was based upon the assumption that the crater of an ulcer will retain a salt of bismuth, after the normal mucosa has been cleared of it by the peristaltic action of the stomach and intestines.

Their method consisted in making several skiagraphs of the patient's stomach at definite periods after the administration of bismuth.

They took the first skiagraph from 4 to 6 hours after the first bismuth meal, this interval representing the time required for a normal stomach to empty itself. A secong skiagraph is then taken after another meal has been given.

They found, in normal stomachs, the bismuth should be quite rid of the stomach in four hours. If any bismuth remained after that time, they assume that some pathological condition, which interferes with normal peristalsis, or holds the bismuth by the presence of some agglutinant substance which prevents the elimination of the bismuth, obtains, or there is some permanent obstruction. They then compare the first and second skiagraphs. The first plate being the most important is viewed first, and note is made of any isolated spots of bismuth. If, by comparison with the second plate, an isolated spot is detected in the stomach area,

this, they think, is suspicious of an ulcer of the stomach; if outside the stomach area, in the duodenum, they suspect a duedenal ulcer. The character of the ulcer shadow is usually thin, irregular in outline, but circumscribed. There may be more than one. If much of the bismuth is retained, the shadow is larger, generally located at the pylorus. This would point to an obstruction. In such a case it is difficult to say from the skiagraph whether an ulcer is present or not, but, they say, the stomach outline in the second plate usually serves as an aid by throwing light on the true condition. The size of the ulcer may be judged from the amount of bismuth retained at its site; the deeper it is, the larger quantity of bismuth it will retain, and consequently a denser shadow will be seen. In the case of very superficial ulcers the shadow is usually thin, and may often have to be verified by repeated examinations at a shorter interval than the first.

They add this remarkable statement - that the possibility of error due to incorrect interpretation is slight where the preparation of the patient is thorough, and the interval between the first dose of bismuth and the first plate has been carefully timed.

These authors record their remarkable results under the following headings -

1. Ulcers diagnosed by X Ray -

   a. Cases verified by operation (7 cases)

   b. Cases substantiated by presence of cardinal symptoms of pain, haemorrhage and localised tenderness (17 cases)

2. Cases submitted for X Ray examination in which the findings were negative.

   a. Negative findings substantiated by operation (12 cases)

   b. Negative findings substantiated by later clinical history (29 cases)

   c. Negative findings substantiated by autopsy (2 cases)

   d. Negative findings unsubstantiated (6 cases)

3. Cases in which X Ray diagnosis was incorrect.

   2. Ulcer not detected by X Ray (1 case)

   b. Ulcer diagnosed by X Ray. Operation showed Gall-stones. (1 case)

4. Cases clinically ulcer in which X Ray findings were negative -

   a. X Ray examination made two weeks after instituting Lenhartz treatment (1 case)

   b. Clinically duodenal ulcer (1 case)

According to the results published above, a correct diagnosis of the presence or absence of gastric ulcer was made in about 87 per cent of cases.

According to Haudek (38.) (1) the supposition that remnants of bismuth attach themselves to flat superficial ulcers is wrong (2) remaining particlesof bismuth after a bismuth meal, are due to the deposition of the bismuth in pathological niches produced by cicatrisation about ulcers. (3) the penetrating ulcer presents a special form of X Ray shadow, in which there appears to be a diverticulum, and above this shadow there will sometimes occur a gas bag of air similar to the Magenblase of the stomach.
The Roentgen examination of penetrating ulcer according to Haudek, will show (1) an isolated fleck or projection of bismuth near the normally filled stomach (2) a gas bag may be demonstrated above this shadow (3) the bismuth shadow persists in this location and (4) palpation fails to dislodge or disturb the bismuth shadow.

Faulhaber (39.) places eminent value upon the observation of an hour-glass indentation of the stomach in the region of the ulcer. This important point I have mentioned when discussing Barclay's observations, the indentation and hour-glass appearance being the result of spasm. Faulhaber finds that while the hour-glass constriction is almost always present where there is much cicatriaation about an ulcer, it may also be present in the flat florid type of ulcer. Out of 15

cases of hour-glass stomach examined he diagnosed 10 as due to ulcer. Four of these were operated upon and the diagnosis established as correct. Faulhaber concludes that (1) with positive clinical symptoms and the X Ray showing a bismuth fleck or projection upon the lesser curvature, with a coincident and neighbouring hour-glass contraction, the diagnosis of a deep adherent ulcer eventually perforating, may be made with certainty and the case belongs to the surgeon (2) With clinical conclusions of a gastric ulcer, the presence of an hour-glass contraction alone cannot but place the diagnosis of gastric ulcer in the balance.

Reider (40.) does not think a fresh ulcer can be demonstrated, but if the ulcer is of the deep, penetrating type, the diagnosis is possible by the pathological processes demonstrable. The Rontgen demonstration of secondary changes in form and size of the body and openings of the stomach caused by processes of contraction and perigastritis, permits conclusions to be drawn regarding past and existing ulcers, and indicates the mode of treatment. Reider's findings are similar to those I have described by Haudek and Faulhaber. In addition, he mentions the possibility of a subprenhic (false) pneumothorax - i.e. a gas containing abscess in and above the liver resulting from a perforating ulcer.

The X Rays in such a case shows the diaphragm pushed upwards by the gas, while the underlying collection of pus will show a sharp line at its surface, and succussion may be shown by shaking the patient. Perigastric adhesions of the stomach wall to the abdominal wall are shown by the fact that excursion of the stomach with respiration and palpation is prevented. Perforations into the small, or large bowel, will permit the observation of the passage of bismuth emulsion from the stomach, as in gastroenterostomy.

Reider devotes some space to the consideration of the intermittent or pseudo-hour-glass stomach which may be dependent on a ulcer, erosion, or other local irritation. He says that such spastic or tetanic contractions of the stomach muscle may persist for some time and must not be confused with organic constriction. (I have already alluded to Barclay's observations on spasmodic constriction).
With reference to these spasmodic conditions Hertz (29.) points out that occasionally the appearance of a slight degree of hour-glass contraction is observed in cases which at subsequent operation show little or no narrowing, but that an ulcer is present near the centre of the lesser curvature. He suggests that the ulcer leads to spasm of the circular fibres, the resulting spasmodic

stricture appears and disappears during the course of the examination; or if the stomach is observed during the ingestion of the meal, one would see the portion of the stomach above the spasmodic stricture fill with the bismuth pudding, then suddenly the spasm gives way and the filling of the stomach appears quite normal. If the ulcer is adherent to the liver, and is upon the lesser curvature, as usually happens, we may have a permanent hour-glass constriction due to cicatrisation about the ulcer. When the patient stands erect, the stomach tends to a vertical position, the ulcer is fixed, and the line of tension is produced diagonally across the stomach, and holds up the greater curvature where the line of tension meets it. The part of the stomach above the line of tension tends to sag down. He reports two cases of extreme hour-glass contraction due to the described phenomenon.

The experiments of Willcox (141.) and Craven Moore (142.) on cases of gastric and duodenal ulcer, in which the diagnosis has been proved by operation, show that an excessive quantity of free and active hydrochloric acid is present in the large majority of such ulcers. This hyperacidity causes the excessive motor activity which I have described, and is no doubt the cause of the pain when ulceration is present, as it may be presumed that the acid stimulates the afferent nerve endings

more strongly when they are exposed in an ulcer than when the mucous membrane is intact. True pylorospasm may be an additional factor in the production of the pain in such cases.

There is an absence of pain in many cases of local spasmodic contraction in the stomach, and this is due to the fact that such a spasm never leads to excessive motor activity in the proximal part of the stomach. When,however, cicatrisation of the ulcer has produced partial obstruction, the ulcer, if not completely healed, may cause a local spasm which makes the constriction complete. In such cases, peristalsis and tetanic contraction may occur in the proximal part of the stomach and give rise to pain. (Hertz)

In this paper by Hertz(43.) he notes that "the pain produced by pressure in the epigastrium in gastric disorders was until recently regarded as a result of direct pressure upon the stomach. When the tenderness was localised to a small area, it was supposed that this area corresponded with the situation of some local disease, such as an ulcer. More accurate comparison between the situation of the tender area and that of the ulcer, as revealed post-mortem and at operations, the fixity of the tender area when the stomach changes its position with alterations in posture and on deep respiration, and the fact, first disclosed by the X Rays,

that the tender area is generally situated entirely outside the area occupied by the stomach, showed that this view was incorrect ... In the large majority of cases epigastric tenderness is a result of the irritable focus in the spinal cord produced by abnormal impulses reaching it from the stomach; pressure on the skin, muscles, and connective tissue, supplied by the irritable spinal segment produces an exaggerated sensory effect. "

Diagnosis of Gastric Ulcer from Carcinoma.

The diagnosis of Gastric Ulcer from Carcinoma is always difficult, and any method which throws any light on such a subject is to be welcomed. A test meal is always essential. In the early stage of Carcinoma X Rays throw little or no light on the diagnosis.

Haudek (44.) lays down some differential points between these two conditions. He suggests that Carcinoma gives the appearance of a filling defect produced by a pathology that encroaches upon the lumen of the stomach; The edges of the bismuth shadow are irregular, and the area of the filled portion of the stomach involved is lessened. On the contrary, the penetrating ulcer shadow is like a diverticulum to the normally filled

stomach, with no material lessening of the gastric lumen. Also, in the penetrating ulcer which has produced quite an area of necrosis in the adherent organ, one will notice a gas bag above the bismuth shadow which is rarely encountered in carcinomatous cases.

Haudek quotes German Surgeons (Knettner and Payr) to state that from 26 to 42 per cent of penetrating ulcers changed to carcinoma. The diagnosis of a penetrating ulcer, therefore, is a step toward the early attack upon an eventual Carcinoma, and the importance of an X Ray examination in suspected gastric ulcer is therefore confirmed.

Summary of Gastric Ulcer.

From X Ray examinations of stomachs with suspected Gastric Ulcers it has been found -

1. That there is excessive motor activity, which may take the form of spasmodic contractions with resulting increased and tetanic peristalsis.

2. That the hyperacidity may cause a true pylorospasm, and as a result the stomach will not empty itself in the normal time.

3. That the epigastric tenderness is not due to direct pressure over the ulcer.

4. In deep, penetrating ulcer, after the major portion of the bismuth meal has passed out of the stomach, there may still be a portion attached to the area of the ulcer.

6. DUODENAL ULCER.

Hertz says (45.) "When the tone of the stomach is excessive, its greater curvature does not reach the umbilicus in the vertical position, and in extreme cases the organ lies very obliquely immediately below the liver. The most common cause of hypertonus is duodenal Ulcer; in a somewhat considerable experience, I have invariably found a hypertonic stomach in this condition unless the ulcer had led to organic obstruction. This is of great practical importance as it assists in the differential diagnosis between gastric and duodenal ulcer, as hypertonus is really found in the former condition. Moreover, when hypertonus is present in duodenal ulcer, the prospect of cure by medical means are generally good; whereas, the slightest degree of dilatation, indicates that a gastroenterostomy is essential in order to overcome the obstruction."
I reproduce his diagram -

Hypertonic Stomach.

In the early stages of Duodenal Ulcer the history and symptoms the patient gives are of the utmost importance as there is no single physical sign indicating the presence of organic disease. Any help from an X Ray examination in this stage is therefore of primary significance, and in suspected cases this should always be made.

In addition to the fact that the stomach is in a condition of hypertonus, one finds the peristalsis very active, and more violent that usual. In many cases the pylorus opens more frequently, and the gastric contents are passed on more rapidly than usual, so that the stomach is sometimes empty in as short a time as half an hour. Barclay (46.) observes "It may be noted in this condition, that just beyond the pylorus there is a separate shadow which is persistent, and is quite unaffected by the peristalsis of the stomach... The picture of a normal stomach exhibiting excessive peristalsis and passing the food on very rapidly, is very suggestive, if not diagnostic of trouble in, or about, the duodenum; but the presence of a separate bolus in the duodenum is accidental, and depends upon the presence of cicatrices or spasmodic conditions causing pockets in the inferior surface."

In almost all the cases of duodenal ulcer examined by Barclay (50.) a separate bolus was demonstrated in the duodenum, and apparently this phenomenon did not exist

apart from conditions, such as ulcer of the duodenum itself, or adhesions from surrounding viscera.
Dr Cole of New York (47.) has studied the Caput Duodeni carefully, and he considers it has no resemblence to the small intestine, but corresponds in size and shape with the stomach. Normally it is dilated into a triangular cap which surrounds the pylorus. Its motor phenomena correspond with that of gastric peristalsis, and it is absolutely free from the small rapid peristaltic contractions of the remainder of the duodenum.
The fact that 90 per cent od Duodenal Ulcers occur in this part of the duodenum may be due to the fact that the chyme in this situation has not yet been neutralised by the intestinal and pancreatic secretions.

Hertz (48.) has studied the question of pain in relation to Duodenal Ulcers, and he contributes the following observations "In a series of cases of Duodenal Ulcer examined with the X Rays I have always found, that the stomach begins to empty itself immediately after the food has been swallowed, and that the evacuation is at first rapid. When the pain begins, two or three hours after a meal, only a small proportion of the food is still present in the stomach, and the hypertonic condition constantly present in Duodenal Ulcer, reaches its greatest development owing to the increase in tone

which occurs as the bulk of the gastric contents diminishes. Under these conditions, peristaltic contractions can produce a complete separation of the pyloric part from the rest of the stomach at a considerable distance from the pylorus. Owing to the excessive and prolonged secretion of normal gastric juice, which is the cause of the so-called hyperchlorhydria of Duodenal Ulcer, the proportion of gastric juice and the quantity of hydrochloric acid in the chyme increase as digestion proceeds. At first, most of the free acid is combined with the proteins of the food, and the small quantity which reaches the duodenum is rapidly neutralised by the alkaline intestinal juice, bile and pancreatic juice, so that the relaxation of the pylorus is only occasionally inhibited. But, after two or three hours, the proportion of acid present being greater, some of it reaches the ulcer before it is neutralised; the irritation of the ulcer increases the inhibition of pyloric relaxation produced by contact of the acid with the intact duodenal mucous membrane, so that peristaltic waves advance against a pylorus, which only opens at considerable intervals, in order to permit the passage of a small quantity of hyperacid chyme into the duodenum. Immediate relief to the pain follows the administration of alkalies or proteins, which neutralise the acid; or of food or water, which dilutes it; relief is also

produced by vomiting and lavage, which remove the acid, and at the same time empty the stomach, so that nothing is left upon which the muscular coat can contract. The pain disappears spontaneously only when the stomach has become completely empty. This generally occurs about an hour after the onset of pain, but if the evacuation of the stomach is hindered by partial obstruction due to cicatrisation, or inflammatory swelling round the ulcer, the pain lasts for many hours. As the sense of fulness is produced by exactly the same mechanism as pain, when the stimulus is less powerful, a sense of fulness is generally felt between two and three hours after food for some months before the first occurrence of pain. At a later stage pain may be replaced by this sensation after some meals, and as Moynihan has pointed out, the characteristic hunger pain is preceded and accompanied by a sensation of fulness, distention, or weight in the same situation"

(49) Albert Walton remarks that in some cases the local arrest of the bismuth meal in the duodenum has led to the diagnosis of a pouch caused by the irregular contraction of an ulcer.

In the early stages of Duodenal Ulcer the following signs can often be made out -

1. The stomach is of the normal shape and exhibits

excellent tone; in fact the tone is often excessive (hypertonus) and it may be difficult for the food to find its way through the stomach.

2. There is very active peristalsis. Such peristalsis is seen in the early stages of pyloric obstruction, but here there is no obstruction as the food enters the duodenum more rapidly than usual.

3. Food leaves the stomach earlier than usual, and the ordinary bismuth meal has probably all left the stomach three quarters of an hour after ingestion.

4. Food can be seen passing through the duodenum. Quite large shadows may be seen travelling from the pylorus to the duodeno-jejunal flexure. Normally, food leaves the stomach in such a fine stream that it is difficult or impossible to follow it through the duodenum. The food in such cases of Duodenal Ulcer passes out from the pylorus in larger quantities at a time than normally, apparently due to sudden intermittent relaxations of the pylorus.

In the later stages of a Duodenal Ulcer, motor incompetence on the part of the stomach may supervene; that is to say, the stomach may not empty itself completely within the normal period of time. This may be the result of spasm on the part of the pylorus - for the spasm no doubt exists because of the need for protection of

the ulcer of the duodenum from the harm which the contact of acid chyme would produce. The obstruction, however, may be the result of the narrowing which results from the healing of the ulcer or ulcers. When the narrowing attains even a moderate degree, hypertrophy of the musculature of the stomach develops, and the evidence of this may be found in the exaggerated peristalsis seen on X Ray examination.

It is often very difficult to distinguish Chronic Appendicitis and Cholelithiesis from Gastric or Duodenal Ulcer. (See case A.B.) 22nd case. Both these conditions may give rise to hypersecretion of gastric juice and this gives rise to increased peristalsis; and in addition, there is a reflex inhibition of pyloric relaxation with resulting delay in the evacuation of the stomach contents. A condition of hypertonus of the stomach is not infrequently produced.

Summary of Duodenal Ulcer.

1. The stomach is normal, or raised in position, and hypertonus exists.

2. Peristalsis is very active.

3. A separate bolus is seen in the duodenum, and this is almost conclusive of Duodenal Ulcer. Apart from Duodenal Ulcer the condition only results from adhesions from surrounding viscera.

7. AEROPHAGY. (Air swallowing)

Barclay (48.) notes that this condition is not uncommon and may give rise to severe gastric symptoms. These patients are always neurotic. On examining the patient with the X Rays it is always found that the stomach contains air which appears to be greater in quantity than usual. On giving bismuth food the outline of the stomach may be perfectly normal, or it may suggest an atonic condition; butit is always noticed as the patient swallows his food a certain amount of air enters the stomach with each mouthful, and the air shadow gradually increases and may extend as much as half way down the stomach, so that the cardiac portion is dilated like a great bubble, occupying the whole of the left hypochondriac region and even displacing the diaphragm upwards. Such patients swallow more air with liquids than they do with solid or semi-solid food, so that any case where this condition is suspected should be tested with a glass of water. Violent and persistent eructations may take place, but it is noticed that the air shadow, instead of becoming smaller, remains the same, or even becomes greater in extent.

VII

SUMMARY.

Summary.

In this Thesis, I have endeavoured to show the importance of X Rays in the investigation of Oesophageal and Gastric Diseases.

There is no doubt that as yet, with our limited knowledge it is difficult, if not impossible, to prove the absence of a definite organic lesion within the Oesophageal and Stomach walls.
On the other hand, such conditions as Oesophageal Obstruction and Pouches, Gastroptosis, Hour-glass Stomach, Dilated Stomach, Pyloric Obstruction, Gastric and Duodenal Ulcers give definite appearances which are capable of correct interpretation by a competent Radiologist.

It may be argued, that in a case of Obstruction, the true Pathological cause of the Obstruction is not diagnosed by Radioscopy. But the scope of the Radiographer lies merely with the interpretation of conditions which affect the physical attitude of the alimentary tract. And it is only by combining radioscopic findings with anamnesis, and where possible chemical examination, that one can hope to throw true light upon the pathological anatomy of any particular case.

Before the work of Cannon, with the X Rays, on the movements of the Oesophagus, the findings of Mosso, Kronecker, and Meltzer, went merely to prove the possibility of the existence of peristalsis in the Oesophagus. But, it must be conceded, that these investigators deduced their results under abnormal physiological conditions.

Subsequent to Cannon's investigations, Radioscopy has thrown most light upon the physiology of the Oesophagus.

prior to the advent of Rontgenoscopy, the physiology of the Stomach was investigated solely from the standpoint of its secretory activity, various types of Gastric Fistulae were used, and Pawlow's minature stomach probably gave the most correct findings. Other investigators, of whom the pioneer was Von Leube, hoped to gain knowledge by means of the stomach tube. By none of these methods can the tone, shape and position, motility, and peristalsis be demonstrated. Only by X Rays can tone and peristalsis be estimated, and although the "Dilution Method of Matthieu and Remond" for estimating motor activity is more accurate than the older methods of Klemperer, and the Salol method of Ewald and Sievers, it is still not to be compared with

the findings of the X Rays.

position, size and shape, of the stomach before Reider's work in 1904, depended solely on examination by percussion, auscultatory percussion, inflation etc. And although these methods have become more accurate in the hands of Clinicians, they are condemned by such authorities as Hertz and Barclay as resulting in inadequate findings. For although, by advanced methods, the Clinician can assign the proper position of the fundus and greater curvature, it is of no less importance to have knowledge of the relation of the lesser curvature and pylorus, and this can only be performed accurately by means of the X Rays.

In regard to my classification of Diseases of the Stomach, I had already attempted to introduce the conditions according to the appearances presented on the flouresscent screen. I had, however, to abandon the classification as it led to continual overlapping. As an instance, Gastroptosis may be cited, which would have to be included under the heading of "Alteration in Position", as well as that of "Alteration in Shape". And in the case of Duodenal Ulcer, it would have been included under the heading of "Hypertonus", and "Alteration in Position". Therefore, it seemed more satisfactory,

to classify the diseases, and attribute the findings under each head.

In a case of Disphagia, it is of the utmost importance to discriminate between True Oesophageal Obstruction and Primary Oesophageal Atony, and the X Rays supplies us with an accurate method of differentiation.

At the end of each section of this Thesis, I have summarised briefly the most salient points, and especially indicated the value of X Rays in the diagnosis of the disease embraced within the section.

This Thesis is limited both in the number of cases that have been examined, and in the circumstance that my cases have been picked to illustrate a specific point. But, from the outset, I have merely attempted to indicate that Radioscopy is of value in the diagnosis of diseases of the Oesophagus and Stomach.

The rapid strides, which this method of investigation has made during the last six years, can only testify to its value. And one may hope, that once the importance of the method has become firmly established, many of the difficulties, which at the present moment

VIII.

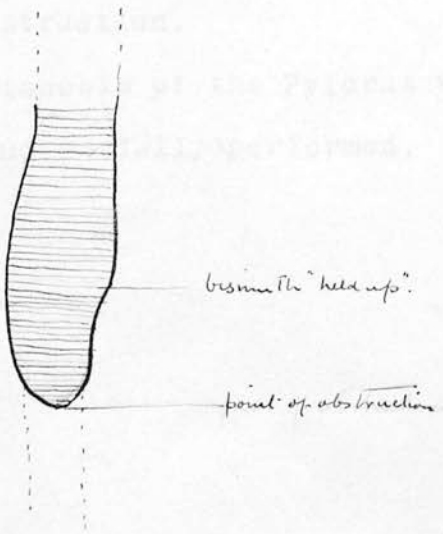
CASES AND PLATES.

Case 1. Plate 1.

J. B. - male - aet 4.

History. This is the case I have described on Page 25. The Boy swallowed hydrochloric acid. As a result, he developed a stricture of the oesophagus.

Description of plate. There is a shadow visible about the level of the fifth dorsal vertebra. This is where the obstruction was present, and the bismuth is seen held up above the obstruction.



Case 20.

C.P. - female - aet 53.

History. She had "indigestion" for some months. On admission, she complained of discomfort and a feeling of weight in the stomach after food. She vomited once every 24 hours, and a large quantity at a time. She was not very wasted. Her previous history was suggestive of gastric ulcer. Test meal showed free HCL, which was not in excess.

X Rayed on 22.10.12. 1st meal - 6 hours after there was a large sickle shaped residue in the stomach. Peristalsis was well seen. The greater curvature was 4 inches below the umbilicus.

2nd meal - showed poor tone but good peristalsis.

Diagnosis. Pyloric Obstruction.

Operation. Simple Stenosis of the Pylorus was found. Gastroenterostomy was successfully performed.

Case 21.

H.P. - male - aet 46.

History. Pain after food and vomiting. Since admission he had almost constant pain, and vomited large quantities of foul smelling material. He was very thin. Test meal showed absence of free HCL and presence of lactic acid.

X Rayed on 30.8.11. The first meal, six hours later, was practically all retained in the stomach which was prolapsed and atonic. There was marked peristalsis.

Diagnosis. Pyloric Obstruction - probably Carcinoma.

No operation as patient was considered too feeble.

Case 22.

A. B. - female - aet 30.

History.

Patient complained of pain which was worse after food, and was frequently followed by vomiting. She was tender just above the umbilicus. No haematemesis. She was pale and anaemic. Test meal free HCL in excess.

X Rayed on 31.12.12.

1st meal - 7 hours later the first bismuth was to a considerable extent retained in the stomach. The position of the stomach was lower than normal and there was marked peristalsis.

2nd meal - showed good tone and good peristalsis.

Diagnosis. A Gastric Ulcer causing pyloric obstruction was thought the probable cause.

Laparotomy was performed a few days later and no sign of ulcer was found, but 25 gall stones were removed from the gall bladder.

This case is interesting and illustrates the point that I mentioned previously, i. e. that gall-bladder trouble may cause reflex spasm of the pylorus and give rise to symptoms of Gastric Ulcer and Pyloric Stenosis.

Case 23.

G. B. - male - aet 49.

History. He had severe pain about half an hour after food and this was frequently followed by vomiting. He had a history of haematemesis and malaena. He was well nourished. Test meal excess of free HCL.

X Rayed on 14.10.11.

1st meal - There was a considerable residue six hours after. Peristalsis was very active.

2nd meal - Showed poor tone in the stomach which was 2½ inches below the umbilicus. Very active peristalsis was present.

Diagnosis. Pyloric Obstruction probably as a result of an ulcer at the pylorus.

Patient refused operation. He was re-admitted a few months later in a state of collapse from Haematemesis. He died, and at the autopsy a large ulcer was found at the pylorus.

Case 24.

J. H. - male - aet 42.

History. He had discomfort, but not actual pain, after meals. He vomited if he was indiscrete in his diet. No history of haematemesis or malaena. He was well nourished and had not lost weight. Test meal HCL was about normal.

X Rayed on 12.12.12.

1st meal - There was a considerable residue after six hours. Feeble peristalsis.

2nd meal - Showed the stomach to be lower than normal with defective tone and feeble peristalsis.

Diagnosis. Dilated atonic stomach. The cause of this was not indicated.

No operation.

Case 25.

J. V. - male - aet 51.

History. This patient complained of constant pain in the epigastrium. He only vomited occasionally. He was well nourished and looked perfectly healthy. Test meal HCL about normal.

X Rayed on 19. 3. 12.

1st meal - Six hours after this meal there was a marked residue in the stomach and feeble peristalsis.

2nd meal - The stomach was dilated and prolapsed; the tone was defective and peristalsis feeble.

Diagnosis. Dilated atonic stomach.

I Have mentioned that this is not uncommon in people with a neurotic temperament. The diagnosis here was considered to be a neurosis.

Case 26.

W. P. - male - aet 47.

History For two years he had suffered from pain in the back about the mid-dorsal region. He had been treated for Muscular Rheumatism. He had shortness of breath, and some difficulty in swallowing solid food.

X Rayed on 15. 2. 13.

On drinking the bismuth emulsion no oesophageal obstruction was evident. But a bismuth cachet was delayed for a short time just below the region of the bifurcation of the trachea. An Aneurism of the Descending aorta was evident on the screen.

Diagnosis. Aneurism of the Descending Aorta causing pressure on the Oesophagus.

He was treated with prolonged rest; dieting; and Pot.Iod., and improved considerably in his symptoms.

Case 27.

W. B. - female - aet 9.

History. For three months she had been suffering from shortness of breath, and lately her neck and face had become swollen, and she found difficulty in swallowing solids. Her face was cyanosed.

X Rayed on 16.7.12.

She was given some bismuth emulsion and this was carefully watched as it descended the oesophagus. About the region of the bifurcation of the trachea there was some slight delay. There were some dense shadows visible in the posterior mediastinum.

Diagnosis. Probably Mediastinal Glands, causing pressure on the oesophagus, and great vessels.

The patient died two months later, and Lymphadenomatous glands were found in the chest.

Case 28.

A. S. - female - aet 25.

History. Pain after food. Vomiting. Epigastric tenderness. No history of haematemesis or melaena. Test meal HCL in excess.

X Rayed on 27. 1. 11.

1st meal - There was no residue at the end of six hours.

2nd meal - Good tone and very active peristalsis were seen. The position of the stomach was about normal.

Diagnosis. Probably gastric ulcer.

The X Ray was instructive in showing active peristalsis and good motility.

Case 29.

J. R. - male - aet 39.

History. The patient was admitted suffering from an attack of haematemesis. He had a history of pain after food though he had never vomited until the present attack.

X Rayed on 24. 5. 12.

1st meal - This was not wholly out of the stomach six hours after. Good peristalsis was seen.

2nd meal - There was poor tone, the stomach was lower than normal and peristalsis was active.

Diagnosis. A gastric ulcer probably at the pylorus giving rise to spasm, or perhaps definite stricture.

Operation. An ulcer was found at the Pylorus. Gastroenterostomy was successfully performed.

Case 30.

L. J. - female - aet 46.

History. She had pain about half an hour after food and this was followed by vomiting sometimes. There was a previous history of haematemesis.

Test meal HCL in excess.

X Rayed on 5.12.11.

1st meal - There was a small residue at the end of six hours.

2nd meal - Position of the stomach a little lower than normal, poor tone, strong and active peristalsis.

Diagnosis. - Probably Gastric Ulcer, but there was not sufficient evidence of obstruction to warrant operation.

Case 31.

R. L. - female - aet 45.

History. For three years she had pain after food, which came on almost immediately after the meal. There was no vomiting, and no history of haematemesis. Test meal HCL about normal.

X Rayed on 5. 7. 12.

1st meal - There was no residue in the stomach six hours later.

2nd meal. Showed good tone, good peristalsis, and the stomach normal in position.

Diagnosis. X Rays gave little or no help here, and one could only say that the stomach was normal.

Operation. Exploratory laparotomy was performed. There was no ulcer in the stomach and no evidence of gall stones; and the appendix was apparently normal. The condition was apparently a neurosis.

Case 32.

E. B. - male - aet 43.

History.

The patient complained of pain which came on at regular intervals, usually 2 or 3 hours after food. It was not relieved by the taking of food. For long intervals he might have no pain whatever. No vomiting. From time to time he had malaena.

X Rayed on 29.3.12.

1st meal - Six hours after this meal there was still a small residue in the stomach.

2nd meal - The tone of the stomach was excellent, there was marked peristalsis, and the stomach was raised about an inch above the umbilicus - a condition of hypertonia was present.

Diagnosis. A Duodenal Ulcer was thought most probable.

The diagnosis was confirmed post-mortem, a large ulcer being found in the first part of the Duodenum.
The patient died from an attack of malaena.

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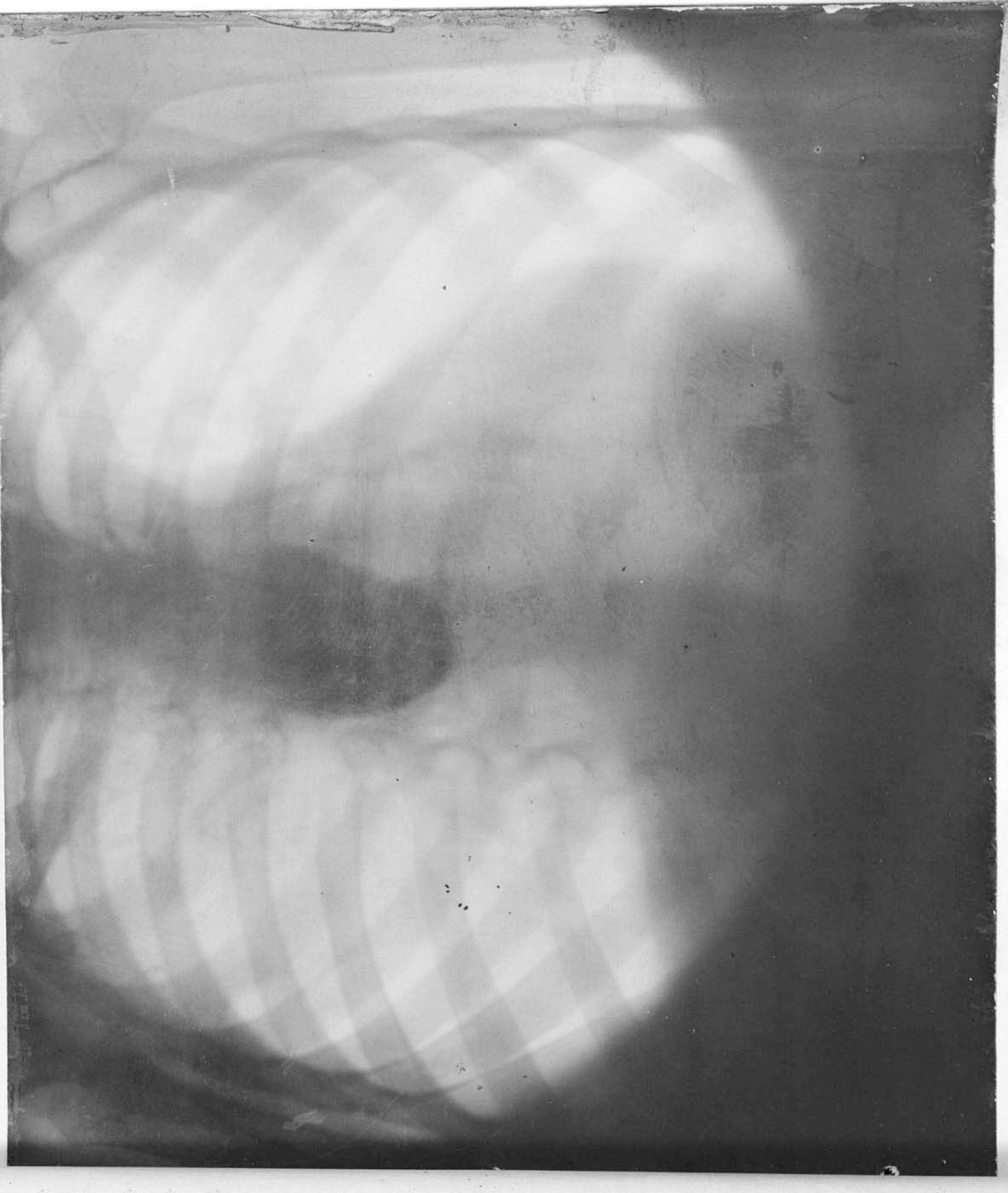


Case 2. Plate 2.

G. S. - male - aet 56.

History.

He had been losing flesh for some time, and from time to time vomited his food immediately after taking it. He said he felt it stick near the lower part of his chest. The patient was very thin.

X Rayed on 13.9.12.

1st Bismuth meal. He vomited most of this meal and therefore no shadow could be seen on screen examination.

2nd Bismuth meal. This showed well marked Oesophageal obstruction at the lower end of the Oesophagus.

Diagnosis.

Oesophageal Obstruction - but the etiology could not be stated definitely.

Description of plate. The oesophagus, in the picture, is seen to be dilated and at the lower end of the shadow a thin line of bismuth can be seen entering the stomach.

Case 3.

C. C. - male - aet 55.

History. For some considerable time - more than a year - he had had difficulty in swallowing some substances, particularly solids. On admission he was only able to swallow fluids, and even with fluids he had very great difficulty. He was very wasted.

X Rayed on 12.7.12. He was quite unable to swallow a bismuth cachet.

A spoonful of bismuth emulsion was given, and it was swallowed with difficulty, and passed down normally until it reached the lower end of the Oesophagus, where it was held up for fully a minute before entering the stomach. He could only be persuaded to take two or three spoonfuls of the emulsion, but obstruction was definitely made out.

Diagnosis. Oesophageal Obstruction at the lower end.

Case 4. Plate 3.

E. W. - female - aet 33.

History. She had a feeling of weight after meals and nausea, but seldom vomited.

Test meal - HCL present.

X Rayed on 13.6.11 1st Meal. There was still a residue in the stomach. 2ndMeal. This showed that the stomach was gastroptosed about 3½ inches below the umbilicus. The greater and lesser curvature could be easily made out and also the position of the pylorus. There was marked peristalsis. Tone - poor.

Diagnosis. Gastroptosis.

Description of plate. The stomach is seen down in the pelvis, and both the greater and lesser curvature are plainly marked out. The position of the pylorus is also seen. The body of the stomach is stretched and a small amount of bismuth is seen held up in the fundus giving the hour-glass appearance I have referred to when discussing gastroptosis.

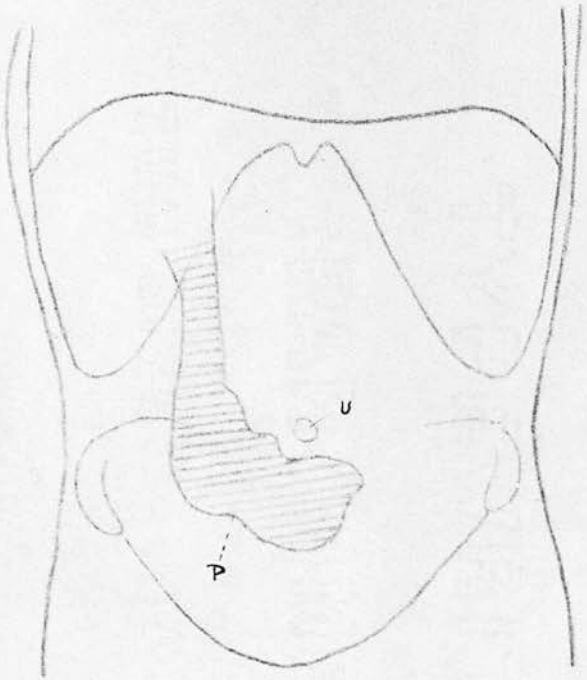
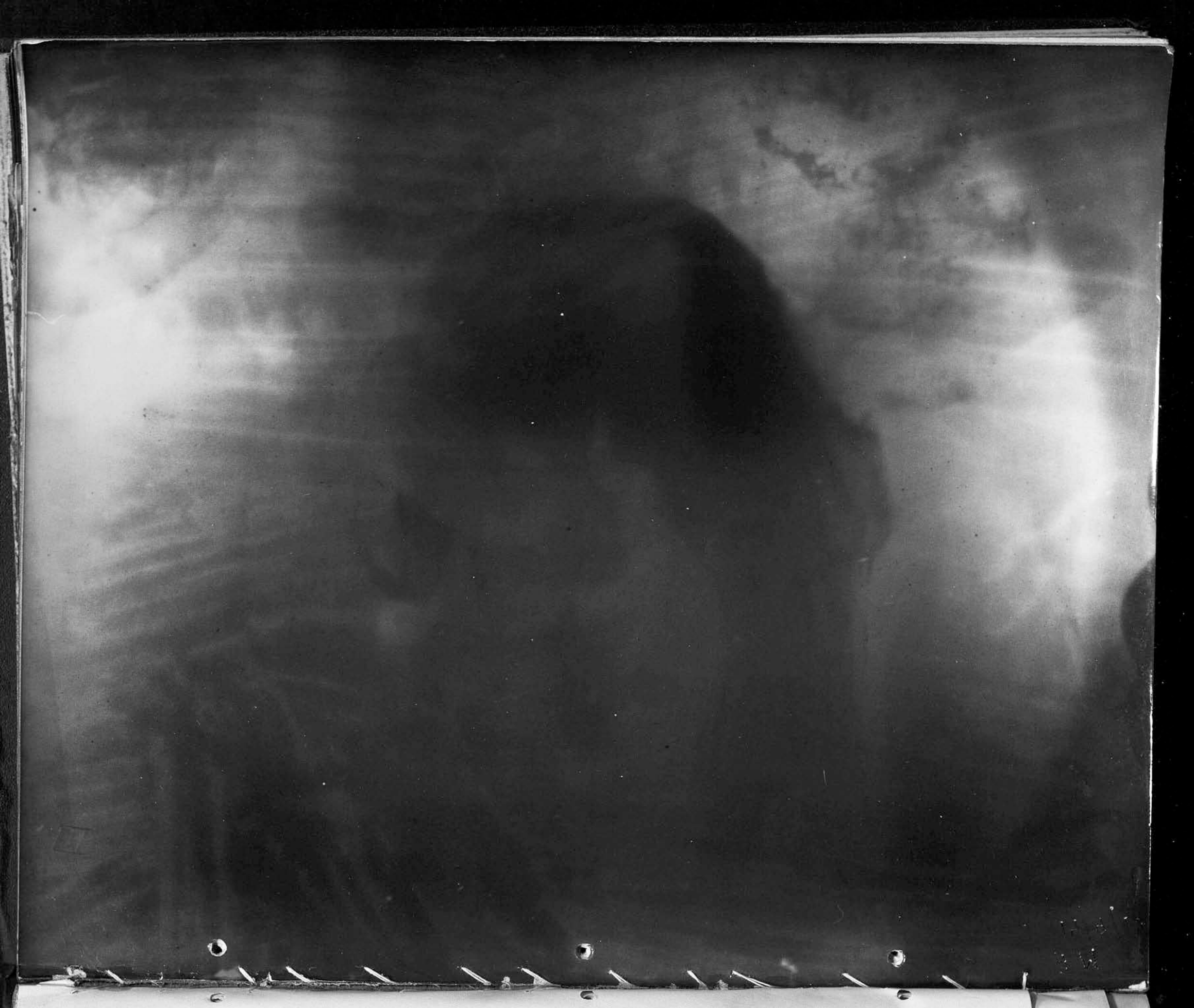


Diagram illustrating Plate 3.

P = peristalsis

U = umbilicus.



Case 5. Plate 4.

J. F. - male - aet 43.

History. "Indegestion" for years. For the last six months he had almost constant pain. Vomits after anything but fluid food, and even after fluid food he occasionally vomits. The patient was very thin and emaciated.

X Rayed on 10. 12. 11.

1st meal - the patient vomited the whole of this immediately after taking.

2nd meal - On getting him to swallow a few mouthfuls of bismuth, one found it collecting in the fundus and not dropping down into the stomach normally. But on watching carefully, a thin streak of bismuth could be seen running down to a second and larger shadow which reached below the umbilicus.

Diagnosis. Hour-glass stomach.

From the manner in which the food leaves the upper sac, it is evident, from what I have already pointed out, that there is a condition of organic hour-glass stomach present, with carcinoma as the probable cause.

There was no operation performed.

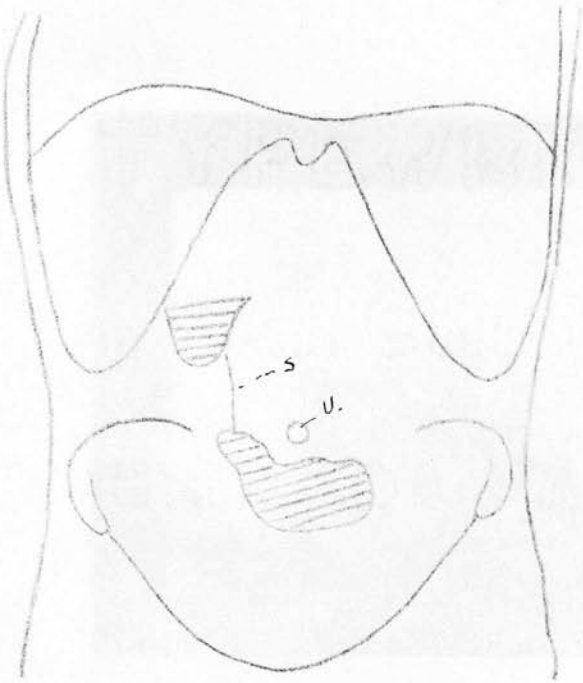
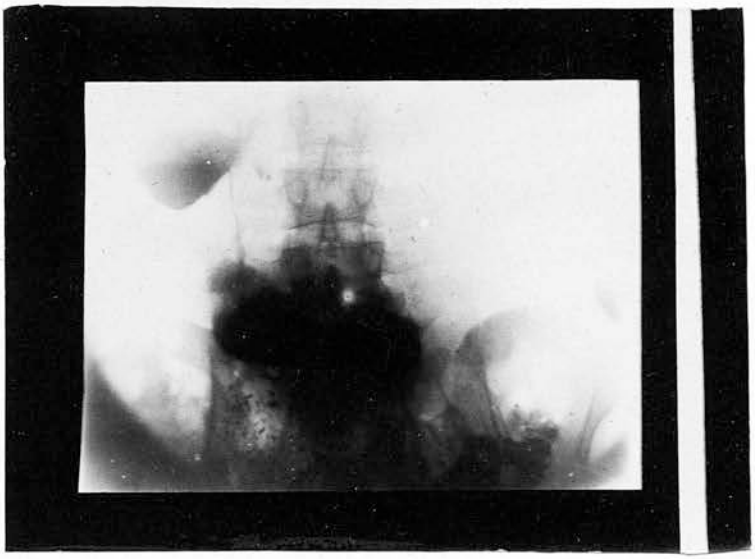


Diagram illustrating Plate. H.

S = thin stream of bismuth running down from upper to lower sac.



Case 6. Plates 5 & 6.

H. B. - female - aet 40.

History.

The patient gave a history of "indigestion" for years. For the past three months she had acute and almost constant pain in the epigastrium. On admission she complained of pain in the stomach, and vomited after everything she took. She was very thin and wasted.

X Rayed on 10. 1. 12. As she vomited everything one gave her, she was not given a meal until the examination. On taking a few ounces of bismuth, the appearance was characteristic. The bismuth was practically held up in the upper sac, but slowly trickled down, and then two distinct sacs were visible, almost entirely shut off from each other. A photograph was taken (See plate 5).

1½ hours later she was again examined, and there was still some bismuth held up in the upper sac, and the two sacs were quite distinct. There was forcible peristalsis in the lower sac. (See plate 6)

Diagnosis. Hour-glass stomach.

No operation.

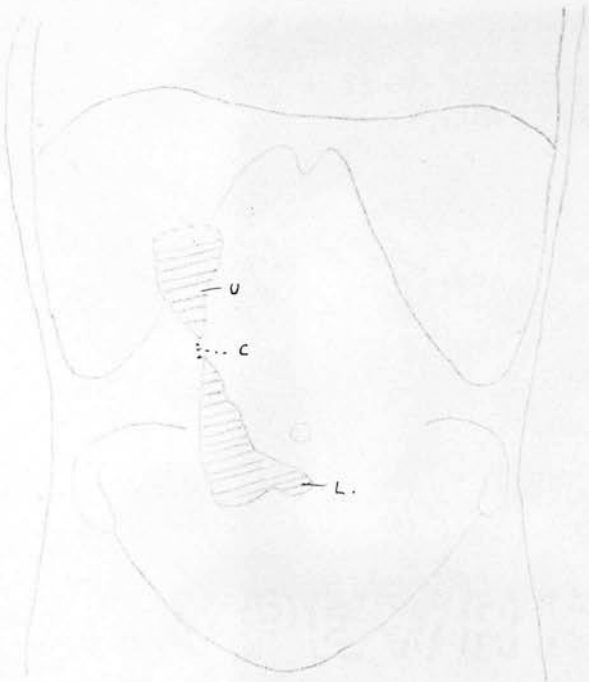


Plate. 5. Diagram.

U = upper sac.
C = constriction
L = lower sac.

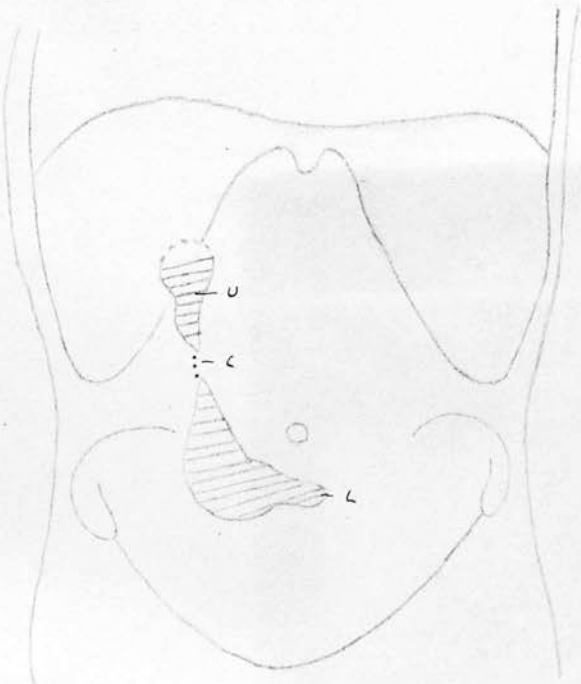
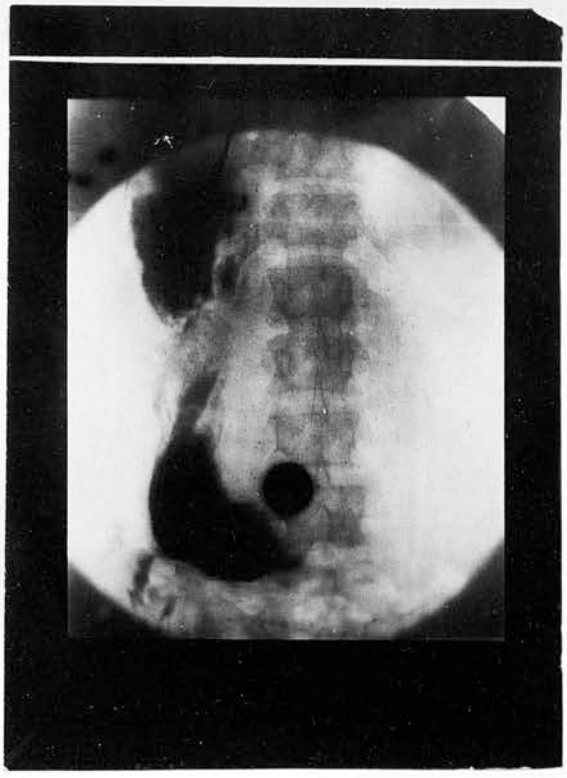


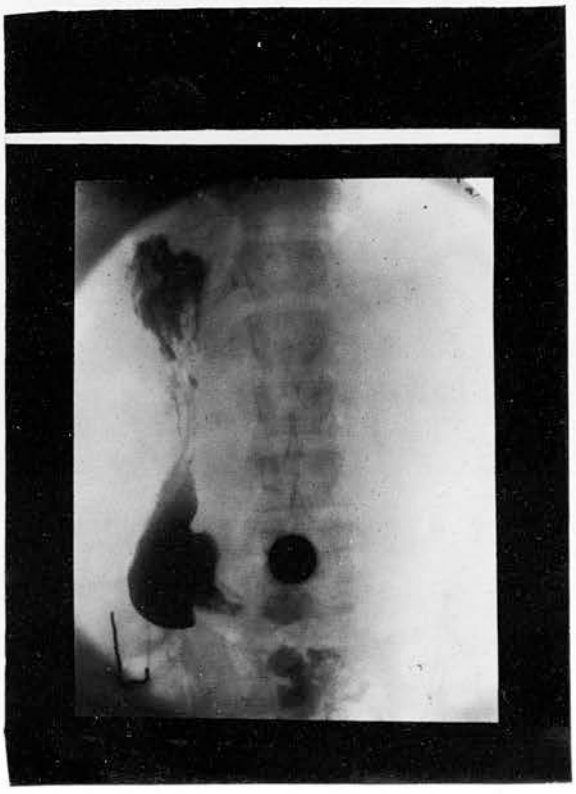
Plate. 6. Diagram

U = upper sac
C = constriction
L = lower sac.

5



6



Case 7. Plate 7.

W. F. - male - aet 34.

History.

Patient complained of pain after food. For the past six weeks he had been unable to retain any solid food. He had got markedly thinner. Oesophageal obstruction was thought to be probably the diagnosis.

X Rayed on 15. 4. 11.

On giving him a few ounces of bismuth meal and immediately applying the screen, one found that the stomach was marked out into two parts - a small upper sac and a larger lower. (See plate 7).
The constriction was not very tight as 1½ hours later the food had all left the upper sac. There was active peristalsis in the lower sac.

Diagnosis. Hour-glass Stomach.

No operation.

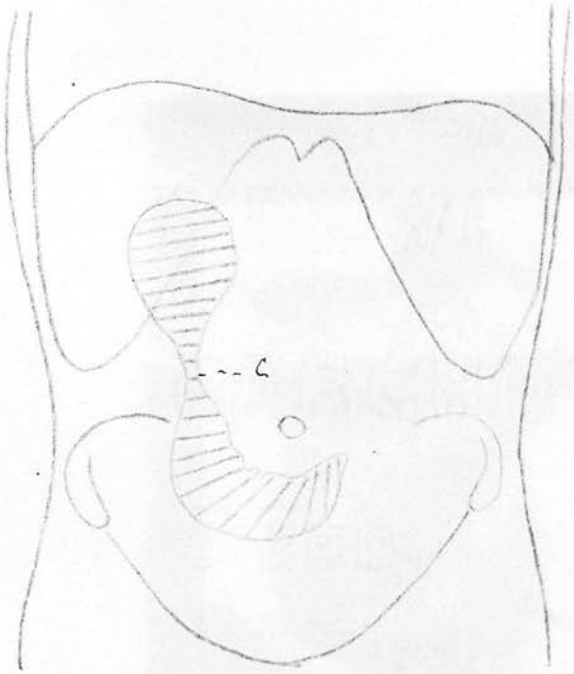
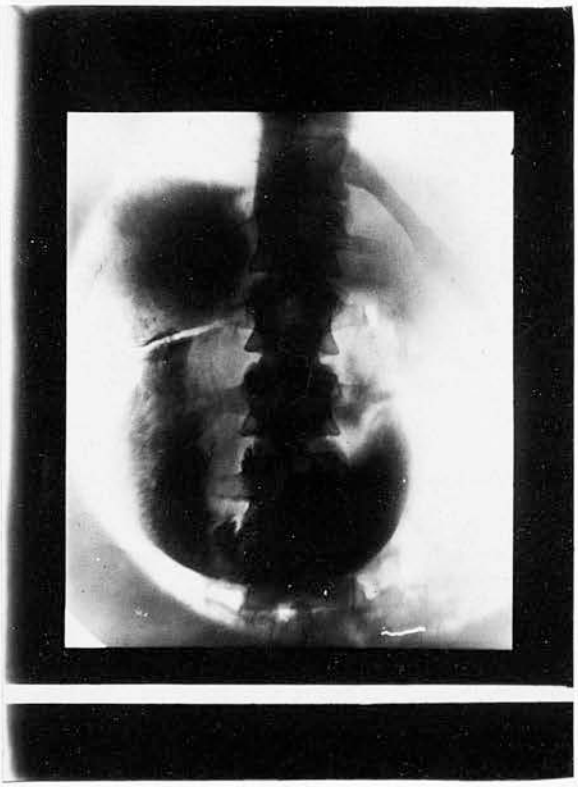


Diagram illustrating Plate 7.

C = Constriction between upper + lower sacs.



Case 8. Plate 8.

W. K. - male - aet 22.

History.

The patient complained ofpains in the epigastrium which was constantly present but worse after food. He did not vomit. On palpating the abdomen he appeared very tender. He was known to be Neurotic.

Test meal. HCL. in excess.

X Rayed on 9.4.12.

1st meal. 6 hours after this meal there was still some residue in the stomach. There was good tone and good peristalsis. (See plate)

2nd meal. Showed the stomach to be slightly lower than normal in position but with excellent tone and peristalsis.

Diagnosis. It was thought probable that he had a gastric ulcer near the pylorus and giving rise to spasm of the pylorus.

Operation. An exploratory laparotomy was performed. There was no evidence of ulcer, the gall bladder and appendix were normal, and so nothing further was done. After operation the patient made a rapid recovery and said his pain was quite cured. This was apparently a purely nervous condition.

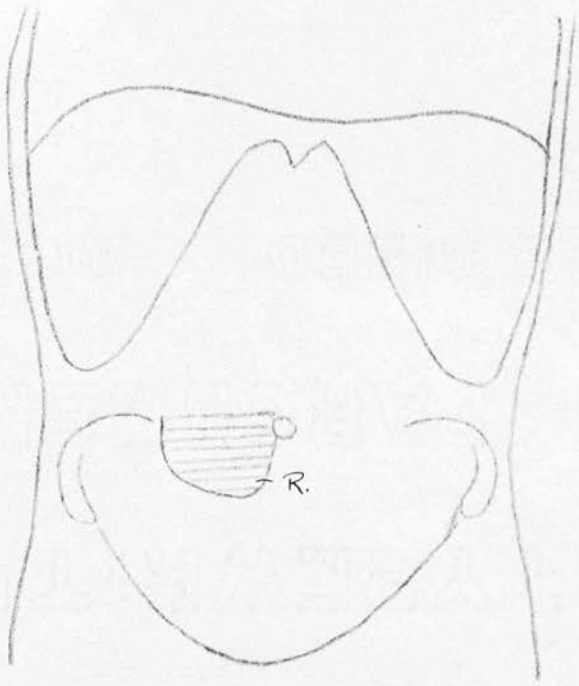


Plate 8. - Diagram.

R = residue in stomach after 6 hours.

Case No 9. Plate 9.

L. O. - female - aet 56.

History.

The patient had suffered from "dyspepsia" for the past 5 years. On admission she complained of pain after food. She vomited some considerable time after food, the vomit being very offensive. She was very thin. No tumour was palpable. Test meal showed HCL present. X Rayed on 16.4.12. 1st meal - There was a considerable residue still in the stomach 8 hours after this meal. The stomach was gastroptosed. 2nd meal - This is depicted in the photograph. It shows the meal in a stomach low down below the umbilicus. The shape of the stomach is normal and this is particularly well shown. Good tone and peristalsis.

Diagnosis. - Was Gastroptosis with possibly pyloric obstruction.

Operation. Pyloric Obstruction was found which was not considered malignant. Gastroenterostomy was performed and the patient made a good recovery.

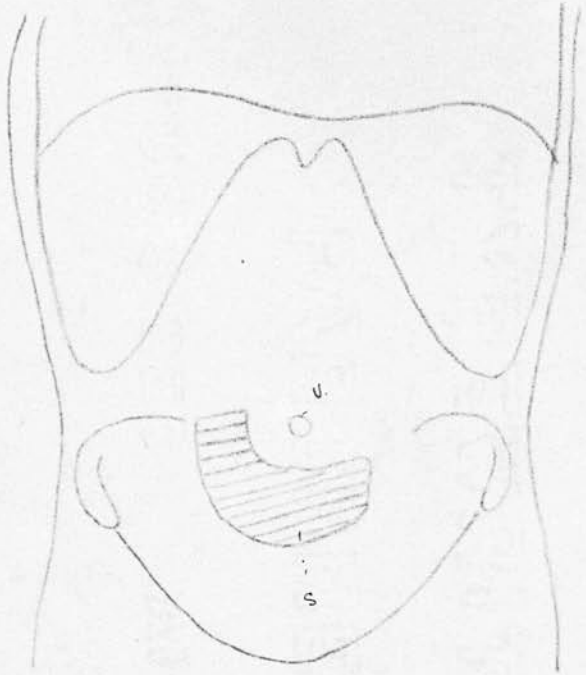
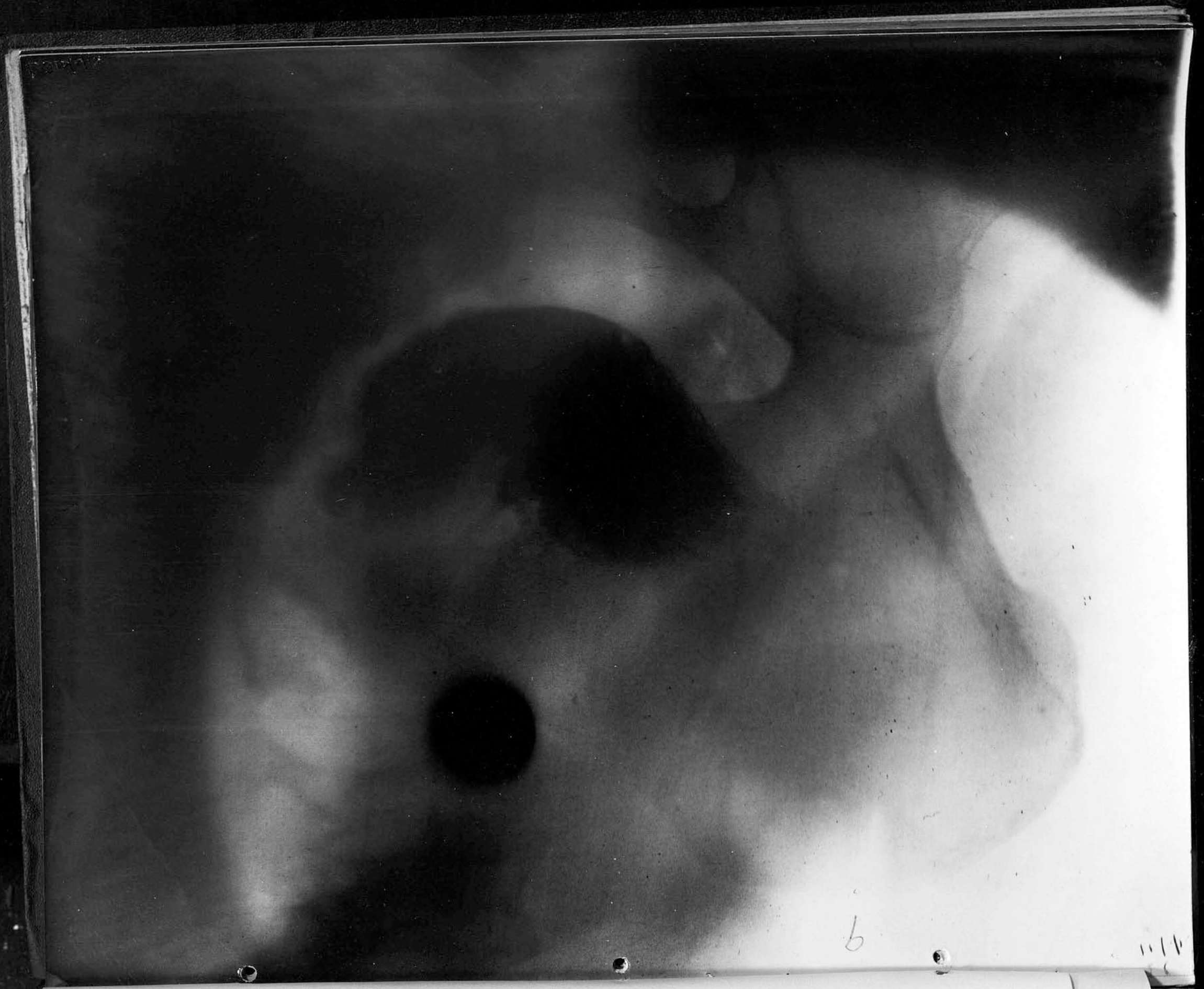


Plate 9. Diagram.

S = stomach showing greater & lesser curvatures and below the umbilicus.



Case 10. Plate 10.

W. P. - male - aet 55.

History. For about two years he had suffered from discomfort after food, which had increased considerably, and he constantly had a feeling of weight in the stomach. He vomited frequently no matter what diet he took. There was nothing palpable in the abdomen but splashing in the stomach could be readily elicited. He was thin and moderately wasted.

X Rayed on 11.6.12. 1st meal - 6 hours after the meal a marked residue remained in the stomach. There was strong and active peristalsis (this is well seen in the picture) and the stomach was dilated, atonic and markedly prolapsed. Some bismuth had reached the caecal region. A second meal was not considered necessary.

Diagnosis. Pyloric Obstruction.

Operation. At the subsequent operation marked dilatation and gastroptosis were found, and stricture at the pyloric end of the stomach which was not considered malignant. Gastroenterostomy was performed and the patient made an excellent recovery.

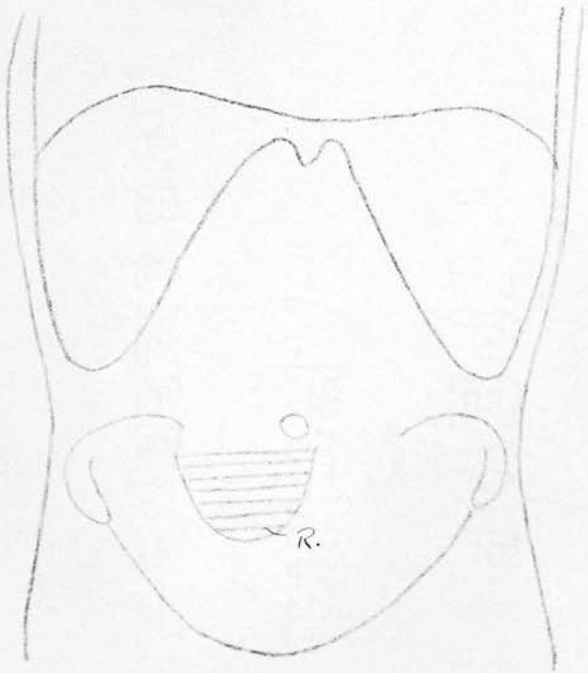
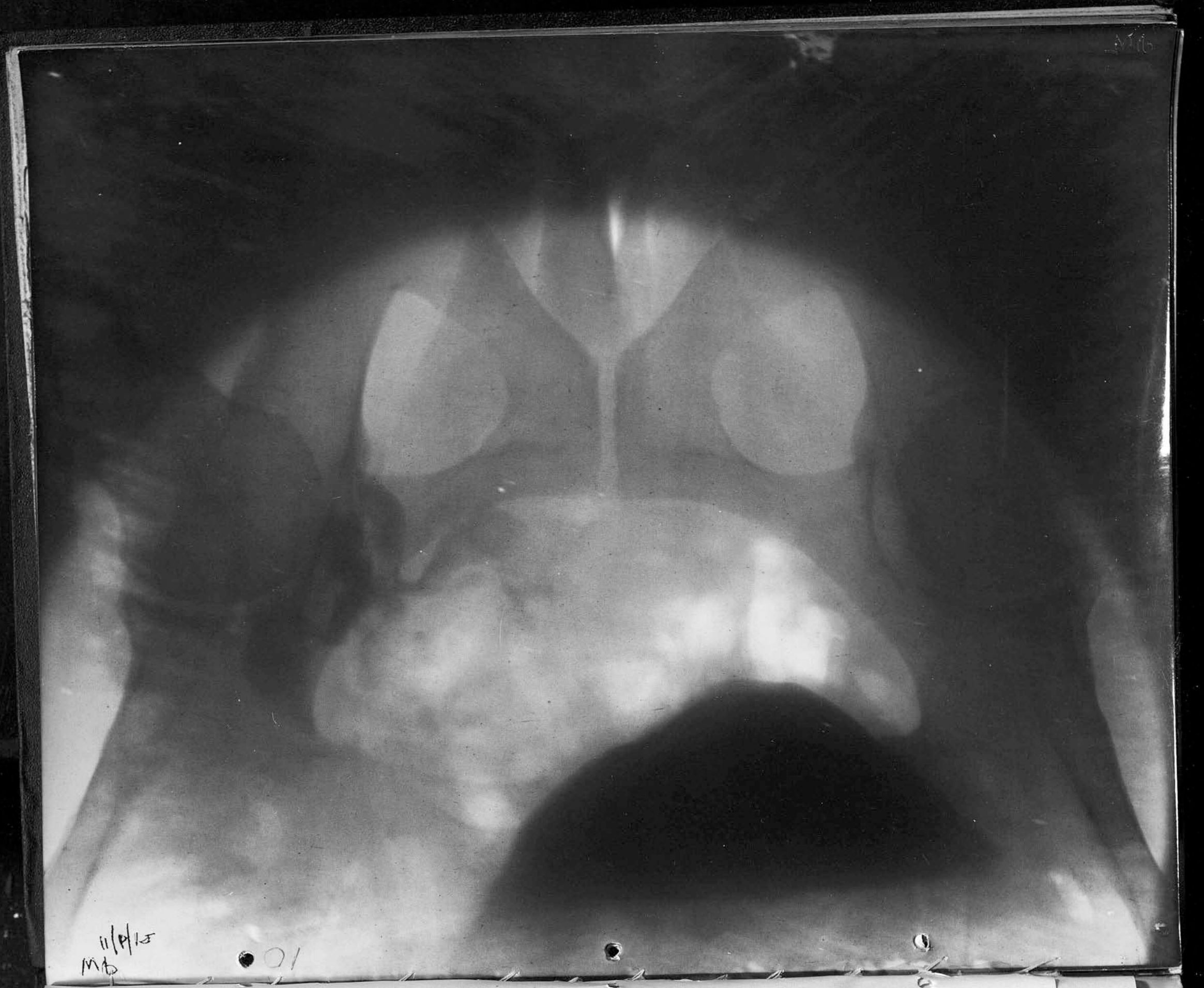


Plate 10. Diagram

R = residue in stomach after 6 hours.



Case 11. Plate 11.

A.A. - female - aet 33.

History. She had a constant feeling of discomfort in the stomach region, and this was increased after food. She vomited large quantities of foul smelling fluid. History of haematemesis 2 years previously. Test meal showed HCL in excess.

X Rayed on 7.2.13. 1st meal - 4½ hours after this there was a marked residue in the stomach which was displaced downwards. Very active peristalsis was seen.
Six hours after (see photo) there was still a large residue in the stomach with very active peristalsis.
Some of the bismuth had been returned to the fundus by antiperistalsis.

Diagnosis. Pyloric Obstruction probably from an ulcer at the pylorus.

Operation. - An ulcer was found at the pylorus giving rise to obstruction. Gastroenterostomy was successfully performed.

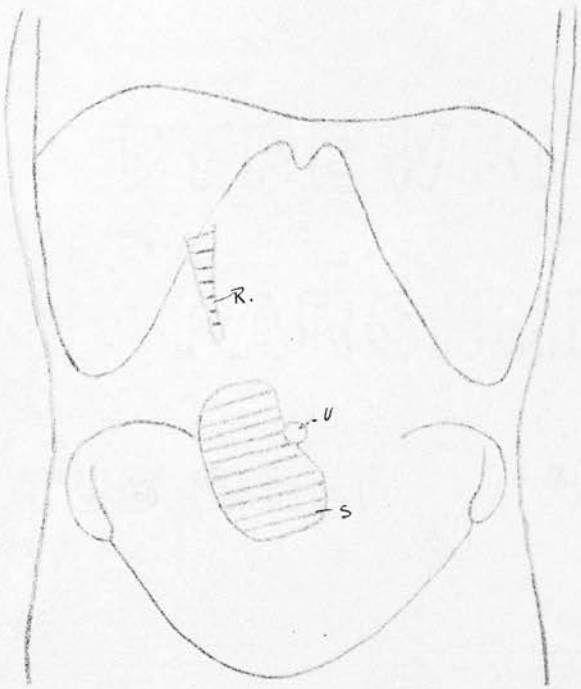


Plate II. Diagram.

S = residue in stomach after 6 hours

R = bismuth regurgitated into fundus by antiperistalsis.

U = umbilicus.

AA

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Case 12. Plate 12.

C.M. - male - aet 44.

History. His illness began about 18 months previously. He had discomfort after meals and occasional vomiting. On admission he had considerable discomfort in the stomach and vomited large quantities of food and fluid, the amount vomited being much in excess of what he ate. He was not badly nourished. There was no blood in his vomit, or stools. Test meal showed presence of free HCL but not excess.

X Rayed on 15.1.12. 1st meal - 6 hours after it was found that practically the whole meal had been retained in the stomach, no bismuth shadows being visible elsewhere. There was active peristalsis.

2nd meal - was not considered necessary.

Diagnosis. Pyloric Obstruction which might be Carcinoma or Ulcer at the Pylorus.

Operation. Pyloric Stenosis was found but it was not considered malignant. Gastroenterostomy was successfully performed.

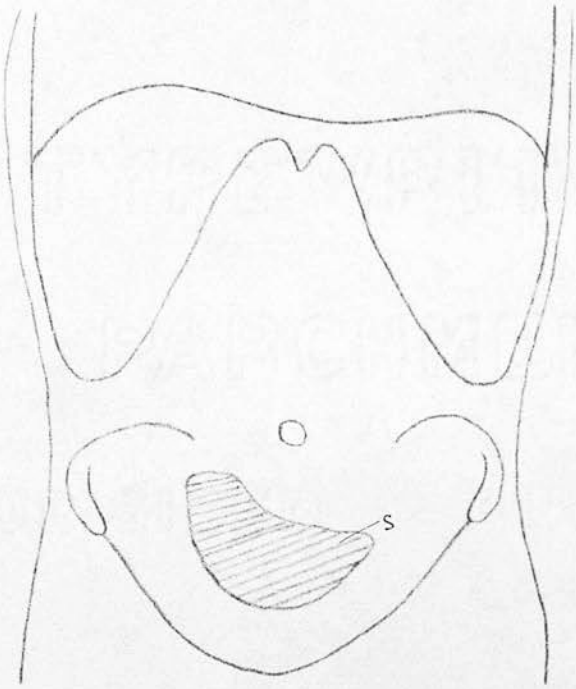


Plate. 12. Diagram.

S = large residue in stomach after 6 hours.

Case 13. Plate 13.

C.H. - male - aet 46.

History. He had suffered from "indigestion" for years. For the previous six months he had been steadily losing weight. He had discomfort after meals, even after fluids, and vomited enormous amounts of food and fluid. On examining his abdomen, the lower border of his stomach could be made out low down in the abdomen and could be seen to move up and down with respiration.

X Rayed on 23.2.12. 1st meal - Six hours after, there was a large residue remaining in the stomach. The stomach was dilated and considerably below the umbilicus. There was good peristalsis. (See photo)

2nd meal - On administering this it dropped straight down to the most dependent part of the stomach - showing want of tone. There was good peristalsis.

Diagnosis. Here one had good peristalsis but loss of tone and slow motility and a dilated stomach. Pyloric Obstruction was diagnosed therefore and the test meal showing absence of free HCL, Carcinoma was thought probable.

Operation. Carcinoma was found at the Pylorus. This was spreading along the lesser curvature, and there were some enlarged glands. Gastroenterostomy was performed.

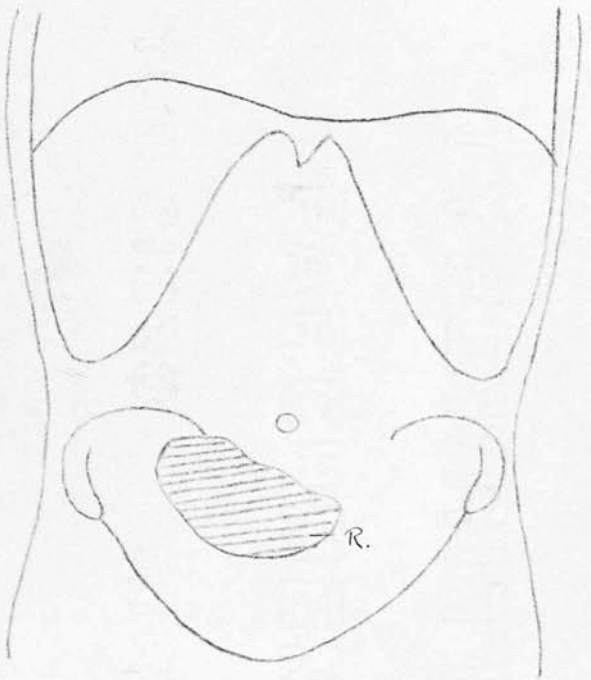
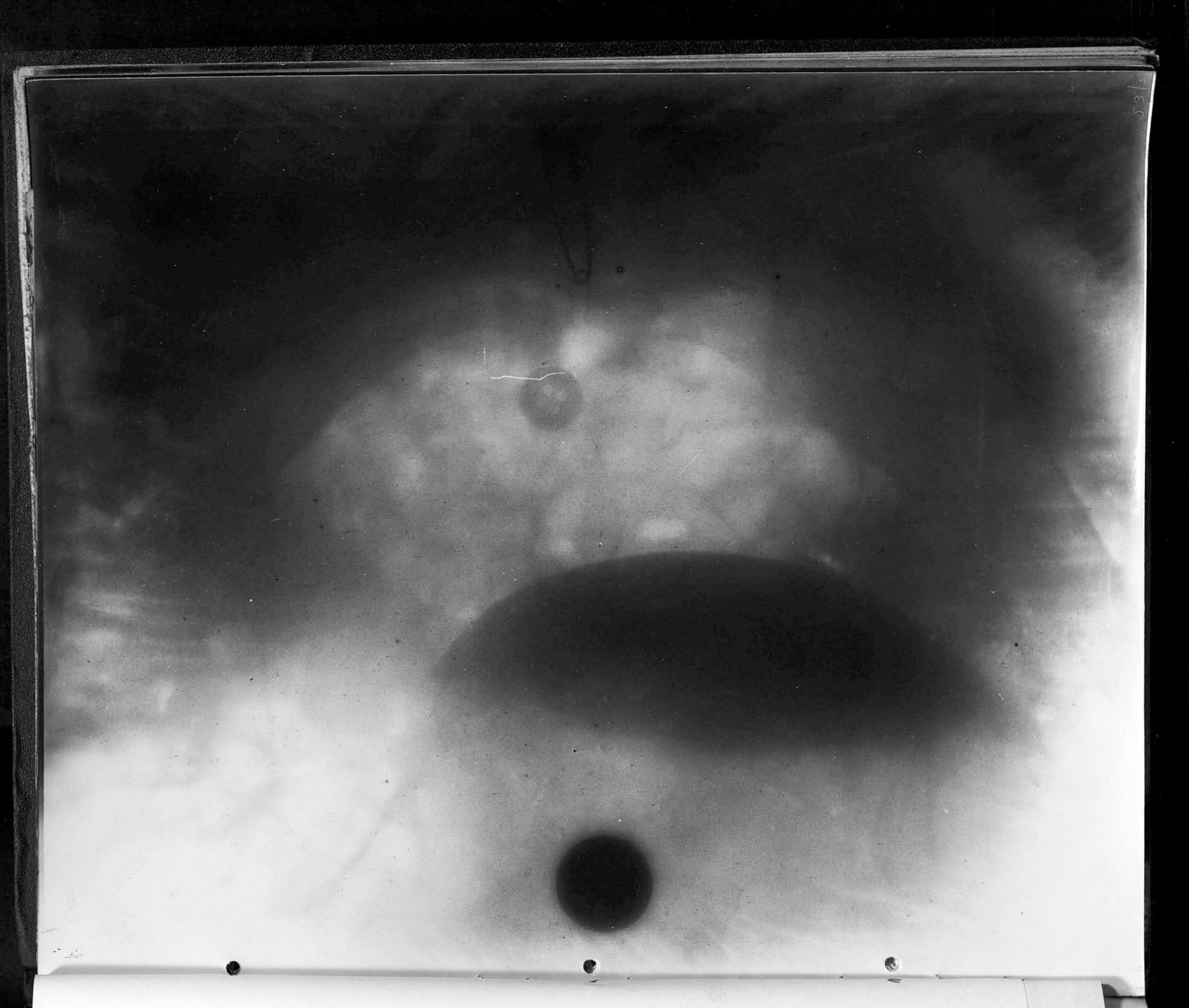


Plate. 13. Diagram.

R = residue in stomach after 6 hours.



Case 14. Plate 14.

H.M. - male - aet 33.

History. He complained of shortness of breath and loss of appetite and obscure gastric symptoms. He seldom vomited. Had no haematemisis, but from time to time he had a small quantity of blood in his stools. Pernicious Anaemia was thought probable, but the blood examination was negative. On examination all his organs were apparently healthy, but immediately below and to the right of the umbilicus was a small round freely movable tumour.

X Rayed on 17.9.12. 1st meal - 6 hours after a small quantity of bismuth was retained in the stomach, the tone of which was good, and its position normal, or perhaps a little raised.

2nd meal - showed position normal, good tone and peristalsis.

Diagnosis. - An ulcer near the Pylorus or in the duodenum was thought probable. The tumour described may have been due to glandular enlargement.

Operation was refused.

Case 15. Plate 15.

W. P. - male - aet 65.

History.

He had a gastric history extending over two years. He had got markedly thinner the past 6 months. He vomited everything given him.

Test meal - no free acid, but presence of latric acid.

X Rayed on 14.4.12. 1st meal - There was a marked residue seven hours after. The stomach appeared to be pushed towards the left of the spine and considerably above the umbilicus. The shadow gave the appearance of suddenly being cut off towards the umbilicus. There was well marked peristalsis.

Diagnosis. Carcinoma of the pyloric end of the stomach, or Pancreas which was pushing the stomach up to the left and also giving rise to Pyloric Obstruction.

The patient was too bad for operation.

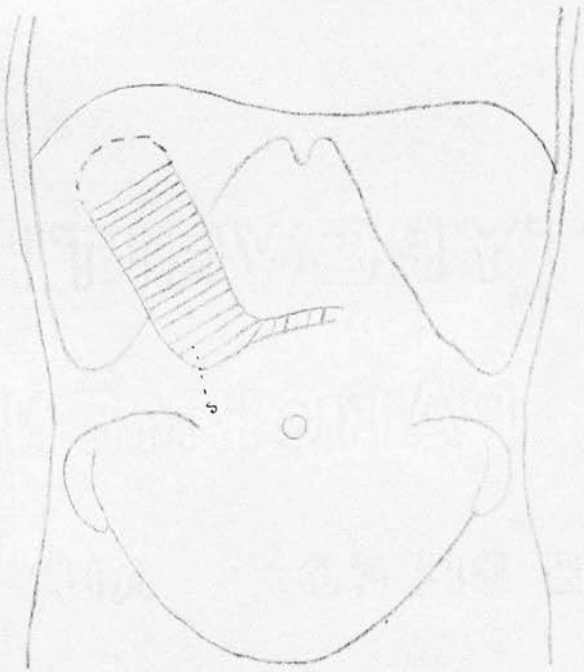
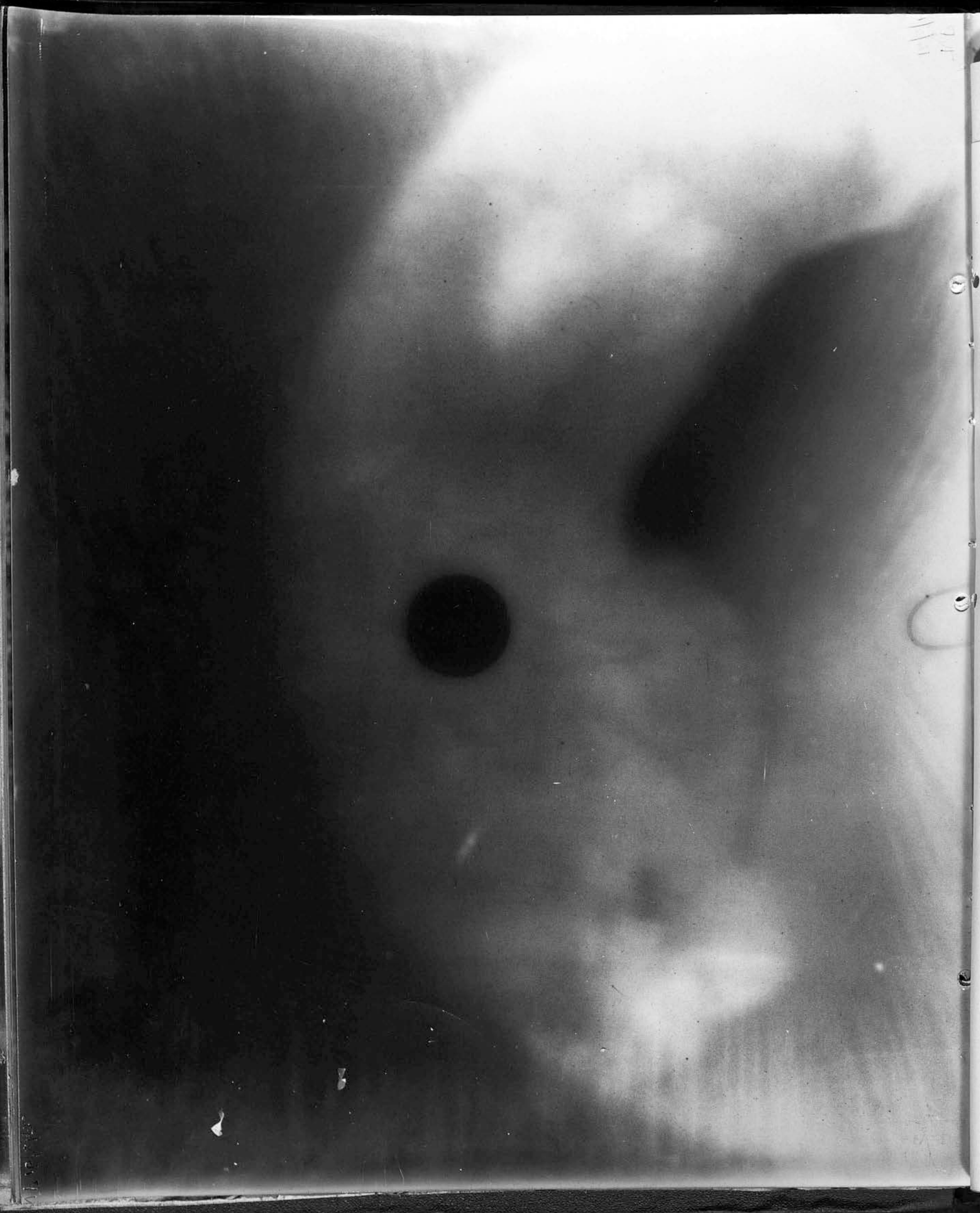


Plate. 16. Diagram.

S = Stomach pushed upwards & to the left.

Note- This diagram ought to have been inserted transversely, as the plate is transverse.



Case 16. Plates 16 & 17.

W. D. - male - aet 63.

History. He had severe pain in the stomach which was constantly present, and vomited everything he took. His history extended over 18 months. He was very thin and wasted and an indistinct swelling was made out above the umbilicus. Test meal - no free HCL. presence of lactic acid.

X Rayed on 10.12.12. 1st meal - six hours after this meal practically the whole of it was retained in the stomach which was pushed upwards and to the left.

Diagnosis. - Carcinoma, causing obstruction, and pushing the stomach upwards and to the left.

He dies six weeks later. Post-mortem refused.

There are two plates. The second one was taken to ascertain if any of the meal had passed on out of the stomach; only a very small portion will be seen lying in the pelvis.

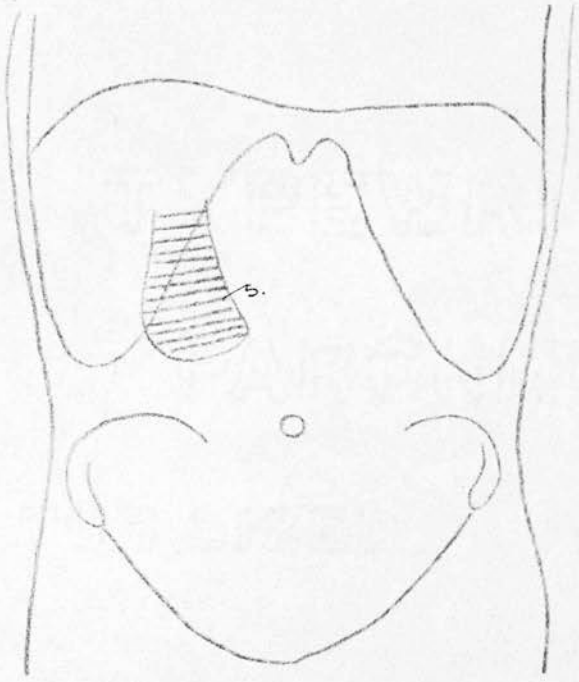


Plate 15. Diagram.

S = bismuth in stomach which is pushed upwards and to the left.

10/13/15

MD

Case 17. Plate 18.

E.M. - female - aet 54.

History.

She had attacks of colicky pain from time to time and vomited at irregular intervals. She was very stout and in consequence part of the distention was over looked. She was very constipated and required very drastic aperients to procure a motion. Nothing could be made out abnominally, rectally, or vaginally.

X Rayed on 16.7.12. 1st meal - 8 hours after the first bismuth meal there was no residue in the stomach, and the accompanying plate shows how the bismuth had reached the small intestine and some of it the Caecum. (The sides of the body are reversed in the plate).

2nd meal - showed the stomach to be normal in position with good tone and good peristalsis.

Diagnosis. The only help the X ray examination gave here was to indicate that wherever the trouble was, it apparently was not in the stomach.

Operation. An exploratory labarotomy was performed and a ring Carcinoma found at the Sigmoid Flexure.

Case 18 Plate 19.

L. F. - female - aet 38.

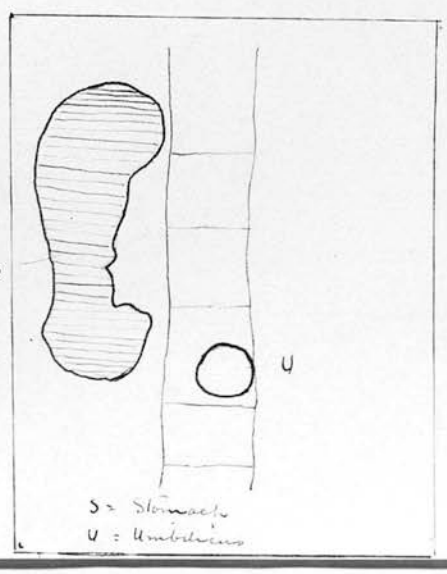
History. She had suffered from "indigestion" for years. On admission she complained of constant pain in the stomach and vomited daily, no matter what diet she had. Test meal showed absence of free HCL.

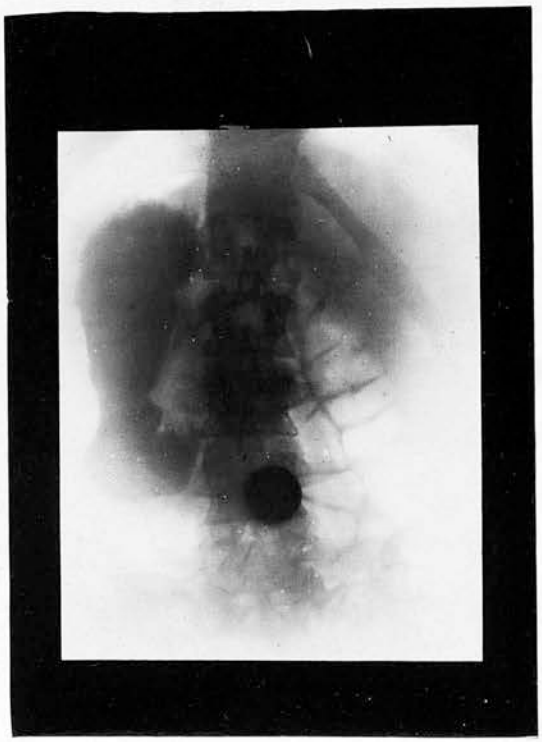
X Rayed on 12. 3. 12.

1st meal - Practically the whole of this was retained 6 hours later; but it was entirely to the left of the spine, and the stomach was higher up than normally. The bismuth shadow ended abruptly towards the pylorus. There was good tone, and very active peristalsis which is well seen in the photograph.

Diagnosis. Carcinoma of the Pylorus.

Operation. Carcinoma was found. Gastroenterostomy was performed.





Case 19, Plates 20 and 21.

J.G. - male - aet 27.

History. He had severe pain after food which came on about an hour after the meal and was always followed by vomiting. There was a history of haematemesis. Test meal excess of HCL.

X Rayed on 12.4.12.

1st meal - There was a large residue at the end of six hours. Good peristalsis. The stomach was gastroptosed.

2nd meal - The stomach was dilated, poor tone and good peristalsis, and gastroptosed.

Diagnosis. Pyloric Obstruction probably from ulcer.

Operation. Simple stricture of the Pylorus was found and gastroenterostomy was performed successfully. Three weeks later the patient was examined with another bismuth meal and in Plate 21 the bismuth can be seen passing from the dependent part of the stomach into the small intestine.

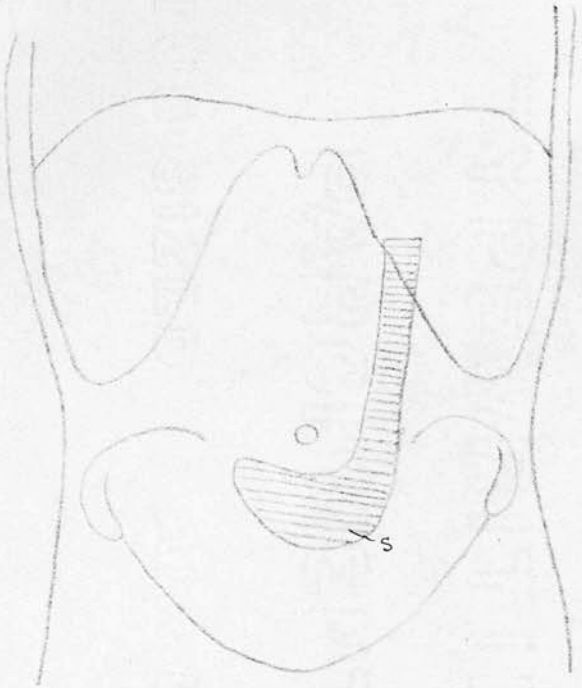


Plate. 20. Diagram.

S = stomach with large residue + gastroptosed.

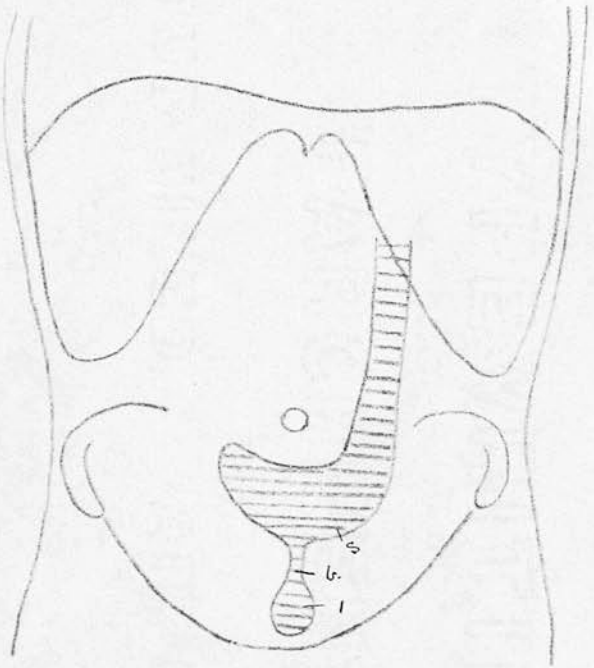


Plate. 21. Diagram.

S = Stomach

b = Bismuth passing into

I = Intestine.